Assessing the potential of rural households to contribute to small hydroelectricity projects:

The case of IWM-E in Nepal

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This research was an incredible endeavour that led me to new grounds, experiences and limits. Both physically and intellectual has this master thesis been an enormous challenge. But I treasure every moment of it that was needed to get me to Nepal, to collect my data and to write this report.
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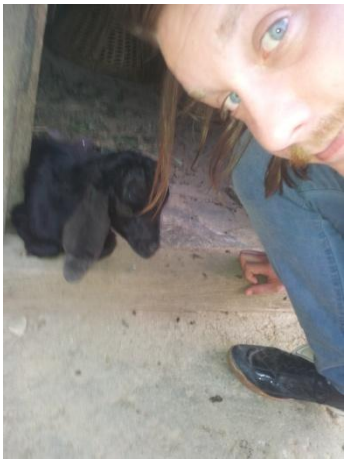
Fanny Verkuijlen.



Executive summary

Access to modern energy sources is an important driver for rural development in developing countries. The majority of Nepal's population, 82%, lives in rural areas and lacks access to electricity. Projects that promote rural electrification yield the potential to reduce poverty, improve health and environmental conditions and reduce gender inequality.

The improved water mill-electrification (IWM-E) programme provides reliable and renewable electricity via hydropower. In order to safeguard the potential of up-scaling the IWM-E programme a more comprehensive overview of the financial model is needed. The current financial model for the installation phase consists of 20% rural community contribution and 80% donor subsidy. A more sustainable model is wanted, wherein the community contribution is increased. This will provide a more stable financial model and increases the sense of ownership and responsibility of the IWM-E communities.

This research conducted a contingent valuation survey to measure the rural households willingness to pay for the IWM-E programme. Furthermore, an ability to pay assessment was made to establish the financial capacity of the community to contribute to the programme. Data was analysed with descriptive and simple statistical analysis. Found is that the financial capacity from the households from this survey amounts to a range of 240 NPR to 360 NPR per month. This creates a basis to increase the households contribution to the IWM-E programme and design a new financial model.

Keywords: renewable energy, improved water mill-electrification, willingness-to-pay, ability-to-pay, rural households

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Abbreviations

AEPC	Alternative Energy Promotion Centre
ATP	ability to pay
CFL	compact fluorescent lamp
CRT/N	Centre for Rural Technology, Nepal
CUG	community users group
CVS	contingent valuation survey
GIZ	German Development Corporation / Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GNI	gross national income
IEA	International Energy Agency
INGO	international non-governmental organisation
IWM	improved water mill
IWM-E	improved water mill-electrification
LPG	liquefied petroleum gas
MW	megawatt
NPR	Nepali rupee
PEU	productive end-use
RET	renewable energy technology
SNV	Netherlands Development Organisation / Stichting Nederlandse Vrijwilligers
UNDP	United Nations Development Programme
WEA	World Energy Assessment
WTI	willingness to invest
WTP	willingness to pay

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1. Introduction

1.1 Energy resources in the developing world

Energy is a primary facility to development of a society, since long we make use of natural resources and convert them to energy for our daily needs (Kaundinya *et al.,* 2009). It is widely accepted that for a sustainable future it is important to switch to a higher dominance of renewable energy (Kajikawa *et al.,* 2008). The productive benefits of renewable energy on mitigation of climate change are stated by the 5th assessment report of the IPCC (2013). Furthermore, an absence of electricity and a dependency on traditional energy sources is described as energy poverty. Emphasizing the nexus between development and energy scarcity (Bhattacharyya, 2012; Banerjee *et al.,* 2010). In developing countries the expansion of renewable, reliable and affordable energy resources can be seen as a motor to promote overall development (Mainali & Silveira, 2012; Nepal, 2012). Access to modern energy sources yields the potential to reduce poverty, health implications and reduce gender inequality (Gurung *et al.,* 2013; Malla, 2013).

1.2 Energy resources in Nepal

Nepal is a mountainous country, landlocked between India and China. It is home to the Himalayas and approximately 27 million inhabitants (CBS, 2012). 82% of the population lives in rural areas and are dependent on subsistence agriculture for their livelihoods (Malik, 2013; Nepal, 2012). Nepal currently ranks 157 out of 186 on the Human Development Index, falling into the category of 'low human development' (UNDP 2013). Primary basic services such as health care and sanitation are still major issues in Nepal (Malik, 2013). Furthermore, access to modern energy sources is not yet widely available for households (Malla, 2013). As seen in Figure 1, Nepal's energy resources can be divided into three main categories, namely traditional, commercial and renewable energy. The largest share by far are the traditional energy resources, which entail the use of fire wood, agricultural biomass and animal dung. Second are the commercial resources, consisting of petroleum, kerosene, coal and electricity. Finally, a small share is made up of renewable energy sources, consisting amongst others of hydropower, solar-power, biogas and wind-power (Gurung *et al.,* 2012; K.C. *et al.,* 2011).

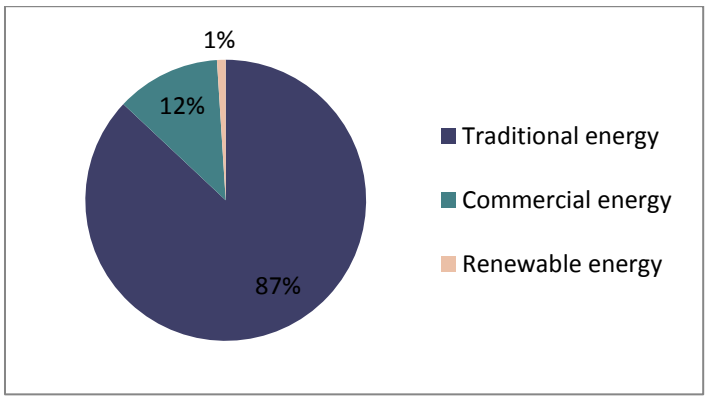

Figure 1: Three categories of energy sources used in Nepal, depicted as share of total primary energy supply of Nepal. Sources: Malla (2013), Gurung *et al.* (2012), K.C. *et al.* (2011), Gurung *et al.* (2011), WCES (2010).

The rural population of Nepal is mainly dependent on traditional energy sources and has little access to electricity (Gurung *et al.,* 2013; K.C. *et al.,* 2011). The main consumptive uses of energy are

cooking and lighting the house in these areas. However, development is upcoming and improvements can be catalysed by expansion of electricity (*Kaundinya et al., 2009)*. Nevertheless, extension of the national grid does not seem to be a viable option for remote areas, where villages are scattered and not easy accessible (Mainali & Silveira, 2011). Fortunately, the country's renewable energy potential is high and small-scale projects throughout the country are set-up.

One of such projects is the Improved Water Mill-Electrification (IWM-E) programme that promotes rural electrification in remote areas of Nepal. The IWM-E programme is a collaboration between AEPC, CRT/N, GIZ & SNV. AEPC, Alternative Energy Promotion Centre, is a government body formed to promote alternative energy technologies, such as IWM-E. CRT/N, the Centre for Rural Technology in Nepal, is a professional non-governmental organisation engaged in developing and promoting rural technologies to aid development. This organisation is responsible for on-site execution of the IWM-E programme. GIZ, Deutsche Gesellschaft für Internationale Zusammenarbeit, is a German Governmental organisation responsible for providing subsidy for the IWM-E programme. SNV, Stichting Nederlandse Vrijwilligers, is a Dutch international non-governmental organisation that is responsible for implementation and monitoring of the IWM-E programme.

Figure 2: Maize grinding by use of IWM-technology. Photo taken by author during research.

1.3 Improved Water Mill-Electrification

The IWM-E programme is a renewable energy project to promote rural electrification in Nepal. The use of water mills for mechanical energy knows a long history in Nepal and is used for various demands of agro-processing, like grinding maize, millet or rice. Since the 1980's the technique of the traditional water mills is being upgraded, by CRT/N and GIZ, to improved water mills (IWM) that yield higher outputs and have a longer life span (Figure 2). An IWM has an output efficiency that is 5% to 25% higher when compared to a traditional water mill. Additionally, the lifespan of an IWM amounts to 10 years whereas a traditional water mill needs replacement after approximately 2 years (CRT/N, 2014). Furthermore, the improved water mill (IWM) has the capacity to generate electricity. Current IWM-E technology has the potential to generate 3 to 5 kW of electricity. With this output households can light their houses and operate small electric and electronic devices such as radio, television and mobile phone charging (CRT/N, 2014). Moreover, it is possible to start micro-enterprises running electrical machinery, such as expanding carpentry business by making use of an electrical saw-mill. These business opportunities are described as productive-end uses (PEU's). The potential of PEU's enables the community to start micro-enterprises and thereby boost their economical situation. Leading to development through electrification (SNV, 2014).

In 2013 a collaboration between AEPC, CRT/N, GIZ & SNV conducted a pilot phase where 4 IWM-E's were installed and operated (SNV, 2014). The objected goals of the project were described by SNV as follows:

> *"With three revenue lines from the project, viz., (i) tariff revenue from households for lighting, (ii) tariff revenue from micro-enterprises for processing or powering machines, and (iii) revenue from business activities from micro enterprises; it was planned that the IWM*

community Electrification would make a paradigm shift towards a commercial and market led project." (SNV, 2014)

With this goal the benefits of electrification via IWM-E technology are diverse, achieving high potential of productive end-use of electricity and community-wide electrification (SNV, 2014).
Moreover, the generation of electricity via IWM-E is based on hydropower, which is a clean energy mechanism and mitigates emission of greenhouse gases.

1.4 Financial model of IWM-E

The financial model of the IWM-E programme can be described by means of 2 components. Firstly, installation of the project requires upfront costs and secondly, operation of the IWM-E requires monthly tariff payments from the consumers. This financial model is depicted in Figure 3.

Figure 3: Pilot phase IWM-E financial model

For the installation costs the community user group (CUG) has to contribute 20% , either in cash or in kind. This means they mainly contribute labour to build the infrastructure needed for IWM-E installation and sometimes provide input of local resources (SNV, 2014). The CUG consists of all the households and the potential micro-enterprise(s) connected to the IWM-E in one village. The remaining 80% of the upfront costs are funded by GIZ (SNV, 2014).
Additional to installation costs, the CUG pays a monthly tariff for the provision of electricity and maintenance costs for the mill owner. Households can opt for a low or high monthly tariff, respectively 120 Nepali Rupee (NPR) or 180 NPR. A low tariff will provide an output of maximum 35 watt, whereas a high tariff provides a maximum of 60 watt. For the micro-enterprise(s) there is a monthly set tariff of 700 NPR. The community user group has to appoint a chairman and are themselves responsible for money collection within the village (SNV, 2014).
The pilot phase showed the potential of IWM-E and paved the road to expansion of the project to further electrify the country. However, the high subsidy contribution in the upfront costs does not provide a long-term sustainable financial situation for the project to be widely up scaled. Therefore there is a need for revision of the financial scheme, wherein the contribution of the community is increased and the distributed subsidy is decreased. This will provide a more stable and sustainable financial model and increases the sense of ownership and responsibility of the IWM-E communities.
The potential of a credit component appears a viable option to enable the country to take on a greater share of the installation costs and thereby reducing the need for donor funds. However, the feasibility of adding this credit component in the financial scheme needs to be researched from both

the side of the financial institutions distributing credit and the financial capacity of the households taking on a loan.

1.5 Academic relevance

This study will provide a relevant case-study to show the potential of credit provision to rural households in development projects. More specific, this research will show an elaborate insight into rural financial capacity in remote areas of Nepal in order to promote electrification. This is a field lacking general data (Mainali & Silveira, 2012; Nepal, 2012 Mainali & Silveira, 2011). The financial options, such as credit potential or subsidies, have been widely described in literature, regarding Nepal but also other developing countries (Rao *et al.,* 2009) However, data concerning actual ability to pay assessments of rural households is lacking. There is a need for further research in the roles of innovative energy options, with appropriate policies and financial models to enable modern energy access in developing countries (Chaurey *et al.,* 2012; Glemarec, 2012).
This research will add to that field. Furthermore, this research is complementary to the work from V. Oonk and, when combination, will provide a comprehensive financial study of rural populations in Nepal.

1.6 Research question

In this report the financial capacity of the households in the selected IWM-E sites and the potential of taking on a loan is explored. This paper aims to answer the following research question:

'What is the financial capacity of rural households in the IWM-E programme to increase payment contribution to the installation costs?'

Sub-questions to support the main question are described as follows:

A. How do income and expenditures of the households relate to each other? And which energy sources are used?
B. What is the credit history of households?
C. What is the households attitude towards electricity?
D. What is the households WTP, WTI and ATP for IWM-electrification?

The research is based upon a contingent valuation survey (CVS) assessing a multitude of parameters that are linked to household financial capacity. CVS is an useful tool for gaining insight into income and expenditures that influence households ability to pay (ATP) in the installation of IWM-electrification. And then to map households willingness to pay (WTP) and willingness to invest (WTI) in the project. The objective of the WTP is to measure the maximum amount that respondent are willing to contribute to IWM-E on a monthly basis, this entails the tariff for electricity consumption and the potential credit repayment. The objective of the WTI is to elicit the maximum amount that respondents are willing to invest as upfront costs to the installation of IWM-E. Furthermore, the attitude of the rural community towards electricity and credit history and perception is mapped.
The quantitative research is support by qualitative data gathered from semi-structured interviews with representatives of the rural communities. With this mixed-method approach the research is expected to provide important insight into the financial capacity of the rural communities. Thereby

assisting the Improved Water Mill-electrification project in exploring the potential of incorporating a credit component into the financial scheme.

Chapter 2 of this research will present an overview of important literature on development through renewable energy and the renewable energy status of Nepal. Chapter 3 comprises of the methodology, an analytical framework and the data collection of this research. In chapter 4 the results and their interpretation are discusses. Chapter 5 provides a discussion on the strengths and limitations of this study. And last, chapter 6 concludes this research with an answer to the research question and recommendations for the project and for future research.

2. Literature review

This chapter will give an overview of the relevant literature to the topic of renewable energy. First, energy poverty and development through access to energy is described. Second, the energy status of Nepal is presented and last, financing of renewable energy in Nepal is elaborated on.

2.1 Energy poverty

Poverty is often described as a multidimensional concept, regarding amongst others life expectancy, nutrition, income, housing quality, access to energy and literacy (UNDP, 2010). When poverty is described as earning under $2 a day, adjusted for purchasing power parity, it follows that 40% of the global population is considered poor (Sovacool, 2013). Nonetheless, non-income dimensions also play an important role in measuring poverty. The United Nations Development Programme (UNDP) and the International Energy Agency (IEA) recognise two energy indicators to define poverty: (1) the lack of access to electricity and (2) relying on traditional energy sources (wood, charcoal and/or dung) for cooking fuels (Sovacool, 2013; Jones, 2010). Moreover, the World Energy Assessment (WEA) describes energy poverty by use of the 'energy ladder' (Reddy *et al.,* 2000). The concept visualises a ladder where each rung corresponds to one type of energy source, respectively, a higher rung on the ladder means a higher energy efficiency and an increased income group making use of this energy source. Accordingly, traditional energy sources are found at the bottom of the ladder and modern energy sources at the top (Sovacool, 2013; Reddy *et al.,* 2000). A representation of the energy ladder is found in Table 1.

Table 1: The energy ladder

		Developing countries			
Sector	**Energy Service**	***Low-income households***	***Middle-income households***	***High-income households***	**Developed countries**
Household	Cooking	Wood (incl. chips, straws, shrubs, grasses and bark), charcoal, agricultural residue and dung	Wood, residues, dung, kerosene and biogas	Wood, kerosene, biogas, LPG, natural gas, electricity and coal	Electricity, natural gas
Household	Lighting	Candles and kerosene (sometimes none)	Candles, kerosene, paraffin and gasoline	Kerosene, electricity and gasoline	Electricity
Household	Space heating	Wood, residues and dung (often none)	Wood, residues and dung	Wood, residues, dung, coal and electricity	Electricity, oil and natural gas
Household	Other appliances	None	Electricity, batteries and storage cells	Electricity	Electricity

Source: Sovacool (2013)

Statistics from the IEA show that, in 2009, 1.4 billion people worldwide lacked access to electricity of which 85% lived in rural areas. Furthermore, approximately 2.7 billion people are dependent on biomass fuels for cooking, consisting mainly of fire wood (Sovacool, 2013). A majority of the population of Nepal is found at the bottom of the energy ladder, where 78% of the total households relies on traditional biomass for cooking (Malla, 2013).

The effects of energy poverty result in consequences that limit development. These are categorised in four impact categories (Sovacool, 2013; Reddy *et al.,* 2000), which are:

I. Poverty and economic security
II. Household health
III. Gender and education
IV. Deforestation and climate change

The need to spend 20% to 30% of households income on energy sources is the main driver for poverty and economic insecurity in the light of energy poverty. Additionally, poor households often face external costs from healthcare, injuries and loss of time due to the labour associated with collecting and usage of fire wood (Modi *et al.,* 2006). Health concerns are mainly the result from indoor air pollution and physical injuries during collecting. The combustion of biomass cooking fuels is concentrated indoors in houses with poor ventilation and with family members responsible for cooking physically present (Sovacool, 2013). Annually, the global effects of indoor air pollution lead to 1.6 million deaths (Gurung *et al.,* 2013). These health impacts are mainly felt by women, whom are often responsible for collection of fire wood and for cooking. Therefore, women are most prone to illness and this results in energy poverty being related to gender impact injuries. Furthermore, indoor air pollution causing health constraints in children prevent them from going to school, which leads to a lack of proper education as a result of energy poverty (Sovacool, 2013). Next to direct impacts to households, energy poverty leads to indirect global environmental impacts. The use of biomass as primary energy source results in deforestation, emission of greenhouse gases and land degradation (Holdren *et al.,* 2000).

In the light of the consequences from energy poverty, development can be attained by access to safe and affordable energy sources (Bhattacharyya, 2012; Banerjee *et al.,* 2010; Reddy *et al.,* 2000). Access to modern energy sources in Nepal can also support basic needs and reduce poverty, health implications and reduce gender inequality (Gurung *et al.,* 2013; Malla, 2013; Mainali & Silveira, 2011). The opportunities from micro-hydro projects in Nepal have led to a national reduction in the use of firewood and kerosene, an improvement of health and environmental conditions and the creation of local business opportunities (Gurung *et al.,* 2012; Banerjee *et al.,* 2010).

2.2 Renewable energy status of Nepal

Switching from traditional energy sources towards commercial or renewable energy sources in Nepal is an important means of reducing energy poverty. A prime goal in this development is granting access to electricity for Nepal's households. Whether this is via the national grid or stand-alone renewable energy projects (Kaundinya *et al.,* 2009). From the many scientific publications, INGO reports and local governmental statistics it becomes clear that there is still a substantial share of the population that lacks access to electricity (Sovacool, 2013; Mainali & Silveira, 2012; CBS, 2012; Gurung *et al.,* 2011; GoN, 2011; WECS, 2010). Figure 4 gives an overview of recent relevant literature that published statistics on the amount of Nepal's population that currently have access to electricity. Figures vary from a mere 37% of the population (Banerjee *et al.,* 2010) to no less than 76% (The World Bank, 2011). Following, there is little consensus on the actual percentage of Nepal's population having access to electricity. Based on these statistics approximately 50% of the population has access to electricity (Figure 4).

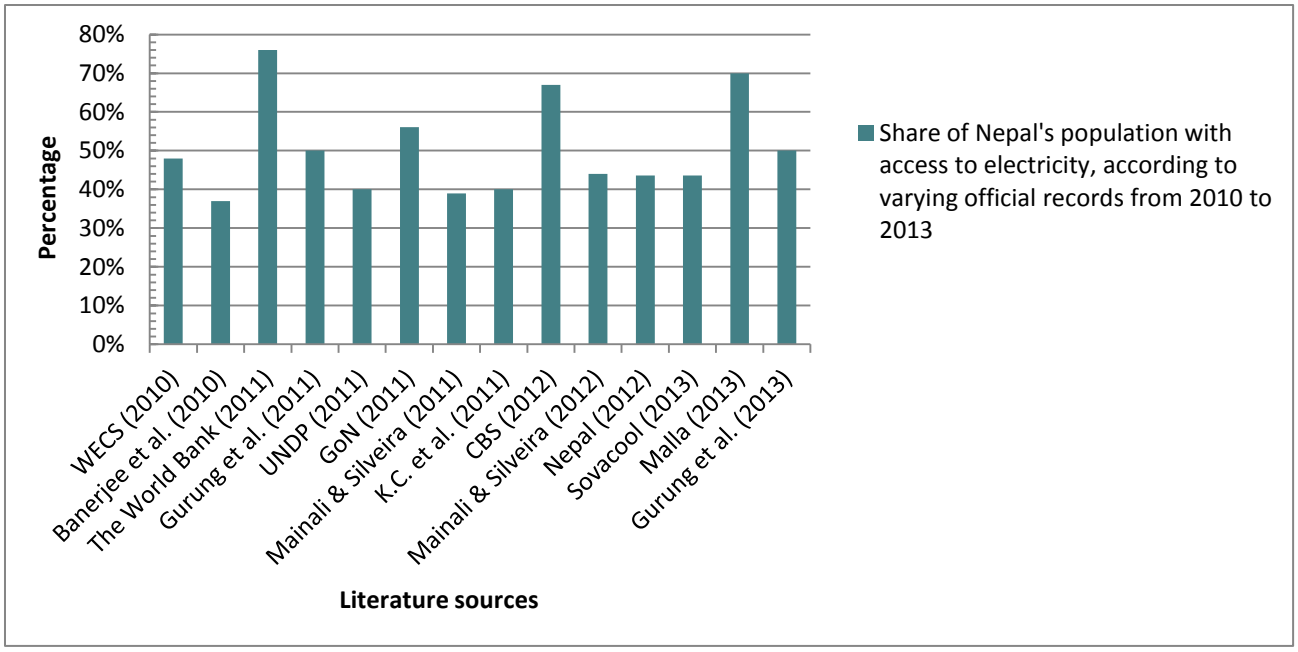

Figure 4: An overview of the percentages of the population in Nepal that have access to electricity according to the official literature.

Nonetheless, strong agreement is found in the fact that the rural population is the predominant group lacking electrification facilities (Gurung *et al.,* 2013; K.C. *et al.,* 2011). Extension of the national grid is not a realistic option for most rural village. Terrains are rough and villages are located in remote areas. Furthermore, equipment and technical costs to deliver electricity via the national grid to many rural areas are high (Gurung *et al.,* 2012). However, the use of renewable energy electrification in rural Nepal provides opportunities and Renewable Energy Technologies (RET's), like hydro-power, are uprising.

The country has an abundance of water resources and yields an annual theoretical potential of generating 83,000 megawatt (MW) electricity from hydropower. Out of this amount 43,000 MW is considered to be economically and technically feasible to produce (Gurung *et al.,* 2013; Gurung *et al.,* 2012; K.C. *et al.,* 2011). This amount can substantially increase the current production of electricity. Which amounted to 705.57 MW in 2011 and thereby fulfilled only approximately 67% of the actual power demand (Gurung *et al.,* 2013).

One of the main obstacles hindering widespread RET's in Nepal is finding funding for the projects (Gurung *et al.,* 2012). Installation of RET's is mainly targeted at the rural level, where the poorest share of the population live in remote areas. These households are at the bottom of the economic pyramid and have little financial means to invest or make periodic contributions. This creates a financial gap between the costs of electrification and the carrying capacity of the rural population (Mainali & Silveira, 2011).

2.3 Financing renewable energy in Nepal

The means of generating financial capacity for RET's consists of several predominant possibilities in Nepal. Mainly, these are a contribution of community equity, governmental or private subsidies and potential distribution of credit to households. (Mainali & Silveira, 2011). However, the distribution of these financial mechanisms is not evenly spread and they are not all equally appropriate to conceive a sustainable financial model.

First, the government of Nepal officially started promoting subsidies for micro-hydropower installations in 1981 and created several five-year plans after that to boost business. Since 1996 the government installed a national regulatory body for renewable energy, the Alternative Energy Promotion Centre (AEPC). Their main goal is the promotion of rural electrification through RET's (Gurung *et al.,* 2012). However, many critiques on government subsidies and policies have been voiced. Actual delivery of subsidies appears to be challenging and bigger projects are favoured under current policy and thereby missing the target group of poor and remote rural villages (Gurung *et al.,* 2012; K.C. *et al.,* 2011; Mainali & Silveira, 2011).

Second, another important player in providing subsidies are private investments of international aid organisations. However, due to an imperfect electricity market, unreliable business models from local organisations and uncertainties in demand these stakeholders are reluctant to invest in RET's (Gurung *et al.,* 2012; K.C. *et al.,* 2011). The need for an independent regulator that creates transparency in the establishment of renewable energy projects is called for (Pokharel, 2003).

Third, the most undiscovered path in financing renewable energy for rural communities in Nepal is the credit component. Its involvement in RET's up to date is very small, however, literature suggests that much benefit can be gained here (Mainali & Silveira, 2011). The addition of a credit component to financing a renewable energy project generates a more sustainable model. Subsidies are not an sustainable source of money and it is desirable that communities increase contribution to projects. To be the motor of their own development and to obtain a higher sense of ownership and responsibility. Several credit component mechanisms are known, namely: Fee-for-service, leasing of energy-generating products, credit from local cooperatives or commercial banks and micro-finance institutions (Mainali & Silveira, 2011). Fee-for-service enables consumers to pay-off the upfront costs over an extended period of time, reducing the impact of high upfront costs.

Currently, loans from development and commercial banks are the predominant credit facilitator for RET's in Nepal. Mainali & Silveira (2011) argue that easy access to credit facilities for households has the potential to help further increase electrification throughout the country. Moreover, achieving modern energy access requires technologies, financial instruments and appropriate financing sources (Sovacool, 2013; Glemarec, 2012)

3. Methodology and data collection

The approach of this research is based on the use of a mixed methodology, combining both quantitative and qualitative research. The form of the quantitative research is a contingent valuation study (CVS) with the goal of measuring the willingness to pay of the respondents and making an ability to pay assessment on the household level. To support the findings, semi-structured interviews were conducted with key representatives of the rural communities.
This chapter will first describe the predominant applied methodology of this study, the CVS, then give an overview of the study site, sample selection and population, and last describe the semi-structured interviews.

3.1 Contingent valuation survey

The contingent valuation methodology is a tool to measure respondents maximum willingness to pay for careful selected services or products. With use of a survey a hypothetical market with varying options is sketched and presented to the respondent, whom is asked to state his preference for the concerning service and level of maximum payment. Design of a realistic contingent valuation scenario is crucial to the success of a CVS. Based upon information from a CVS the most appropriate package can be selected and offered (Breidert *et al.,* 2006; Wedgwood & Sansom, 2003).
Advantages of using of CVS are that it yields the potential to measure respondents willingness to pay for hypothetical services, that do not exist yet. Multiple scenario's can be examined simultaneously and the methodology is conceptually easy to understand. Moreover, the approach of a CVS enables basic financial models to be developed (Wedgwood & Sansom, 2003). Disadvantages of a CVS methodology are that respondents answers can be biased, when false preferences are deliberately stated. Furthermore, the results from a certain site are often not transferable to other locations (Breidert *et al.,* 2006; Wedgwood & Sansom, 2003).
Wedgwood & Sansom (2003) developed an analytical framework to carry out an investment planning process that contains a willingness to pay study for services or goods. The framework is shown in Figure 5 and highlights the position of a CVS in a decision-making process.
The first step in the process is an assessment of current service levels and operations, which would show the potential for improvement. In the case of IWM-E, the pilot project showed the need for a sustainable financial model (SNV, 2014). The second step measures the initial demand, meaning that an assessment is made to elicit if a demand exists for the service. The result from this step will determine whether a continuation with a CVS is in place. In this step, a feasibility study is carried out at the potential IWM-E sites (CRT/N, 2014; SNV, 2014). In step 3 a technical option and costs design is made to represent scenario's for which the WTP is measured. This step precedes the actual CVS and was conducted in this research. Following is step 4, the WTP and consumer survey. This step is the main methodology of this research and shows the position of a CVS in the decision-making process. Step 5 represents the management and operations plan. This means that from a policy perception the financial possibilities of the project are measured, which includes relevant financial stakeholders. This step is conducted in a complimentary research to this survey, executed by V. Oonk. In step 6 the results from all previous steps are combined and an financial projection can be presented. To present this financial scheme is the objective of this research in combination with the research of V. Oonk. The final steps, 7 and 8, are to finalise the planning process. Here, an agreement of the financial

projection is found with the key stakeholders and the project is implemented and monitored (Wedgwood & Sansom, 2003).

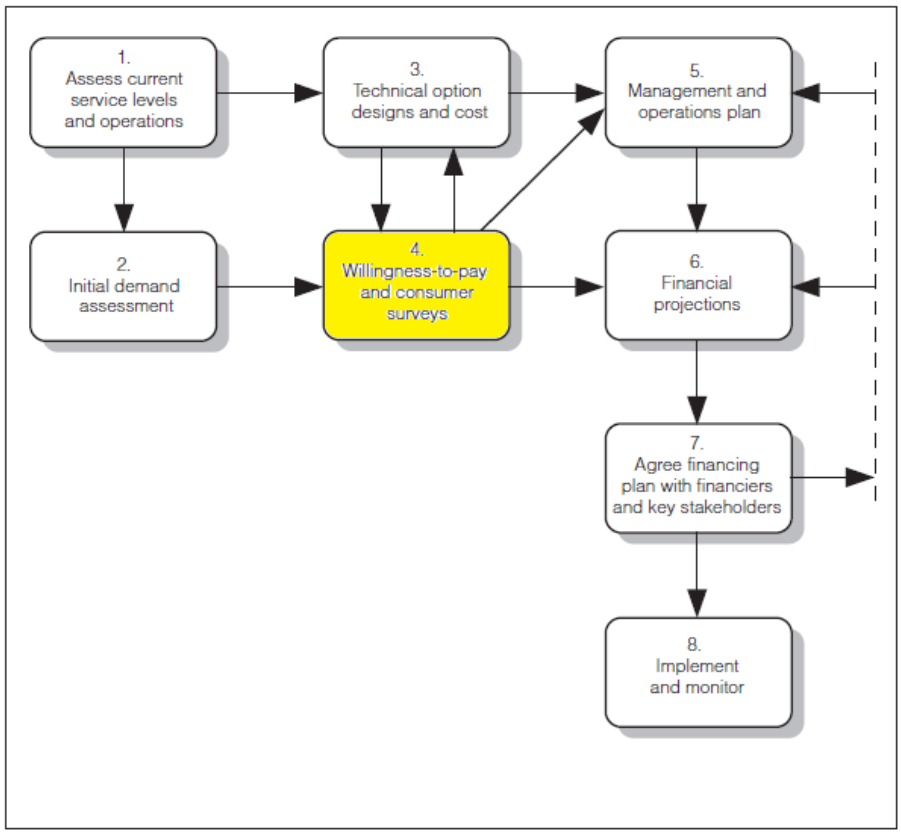

Figure 5: Analytical framework for a planning process containing CVS, designed by Wedgwood & Sansom (2003)

3.2 Questionnaire

The main valuation technique to assess the ATP and WTP of the rural communities is determined by a contingent valuation survey. This method provides a stated preference measurement. The questionnaire and interview questions were based on the main research questions as described in chapter 1. In order to obtain the desired respondents information 10 different parameters were established as basis for the survey, which are described in Table 2.

Table 2: parameters for CVS questionnaire

1	Income
2	Expenditures
3	Financial trade-offs
4	Usage of- and expenditure on current energy sources
5	Willingness to take on a loan
6	Previous loan characteristics
7	Ability to pay (for tariff & equity)
8	Willingness to pay (for tariff & equity)
9	(Spatial) household characteristics
10	Attitude towards electricity

With these parameters the financial capacity of the rural households in the study area was assessed. The households WTP, WTI and ATP for IWM-electrification were measured. Furthermore, the attitude of the rural community towards electricity and taking on a loan were determined. A pilot survey was conducted and questions were carefully analysed and adjusted. The used questionnaire can be found in appendix A.

The questionnaire existed of a combination of close-ended questions, multiple-choice answers and a likert-scale. A questionnaire is a research tool to gather information on the attitudes and beliefs from a sample of individuals. Furthermore, it is the most practical way to gather information regarding the attitudes of stakeholders to an intervention. However, a questionnaire has its limitations. Firstly, one cannot achieve depth, elaboration and complexity, whereas it is possible with an interview. This is due to a fixed set of responses that are given with the questionnaire. In order to circumvent this limitation semi-structured interviews were also conducted (Williams, 2003).

To prevent responder fatigue and increase response rates the questionnaire was kept as short as possible, only questions that really answered the research questions were asked. Furthermore, questions that were similar were grouped together to prevent confusion and to make completing the questionnaire easier. Last, to keep the questions simple abbreviations, technical terms, acronyms and modifiers such as “always” and “sometimes” were avoided (Williams, 2003).

Subsequently, the collected data from the questionnaire was processed with use of Microsoft Office Excel 2007. An elaborate descriptive analysis of the data was conducted and a simple statistical analysis. Furthermore, an ability to pay assessment is executed based on the data collected with the CVS. This research did not aim to conduct an in-depth statistical econometric analysis.

3.3 Site selection and sampling

At the time of commencement of this research, the IWM-E project knew eight sites located in rural areas of Nepal. On some sites there was already an IWM-E present and others were in the process of installation of the IWM-E. Therefore, an installation progress classification was set up for the sites and divided as follows: (1) IWM-E already installed; (2) IWM-E installation in progress and (3) technical potential to install IWM-E.

The communities that were already electrified via IWM-E were from the pilot phase carried out in 2013. The sites where construction is in progress and the potential IWM-E sites were carefully selected based on a technical feasibility study conducted by the local partner organisation Centre for Rural Technology in Nepal (CRT/N). Technical requirements entail amongst others the available water flow and the provisioned output efficiency generating 3 kW. Further requirements of site selection were based upon socio-economic guidelines, such as that the sites should not be located more than 20 kilometres from an identified market place and there should exists no conflict among the community members regarding constructing and operating the IWM-E (SNV, 2014). A more detailed elaboration on the requirements for project sites can be found in the Proof of Concept from SNV (2014).

The study site for this research entails five out of the eight rural communities of the current project, an overview of these sites and their characteristics is given in Table 3.

Table 3: overview of study sites and sample size per site

Site	Village	District	Sample size CVS	Installation progress category
1	Kiranchook – 2	Dhading	7	(2) IWM-E installation in progress
2	Jogimara – 6	Dhading	6	(2) IWM-E installation in progress
3	Foksingtar – 2	Kavre	7	(1) IWM-E already installed
4	Ranichuri – 8	Sindhuli	7	(3) technical potential to install IWM-E
5	Khangsang – 1	Sindhuli	7	(3) technical potential to install IWM-E

The five rural communities from the study site are spread out over three districts in the central region of Nepal. The first district visited for this study is Dhading that houses two category 2 villages where the installation of IWM-E is currently in progress. The two visited villages are respectively Kiranchook and Jogimara. The second district visited is Kavre, where the village is found that has an operating IWM-E and falls into installation category 1. This is the community of Foksingtar. The last district selected for this study is Sindhuli, where respectively the villages Ranichuri and Khangsang were surveyed. These are two potential sites, falling into installation category 3.

For the questionnaires the head of the household or a key decision maker within the household was interviewed. A native interpreter from CRT/N conducted the surveys. The sample size was 6-7 households per village and was based upon stratified random sampling. Each village consisted of 25 households that were or will be connected to the IWM-E, meaning that approximately 30% of the total population per village was surveyed. The strata for the sample size were determined by distance of the house to the IWM-E and were categorized as within 30 minutes walking distance or above. Due to time constraints and a large dispersion of houses throughout the village it was not possible to get an equal sample size per strata. However, the realised sample selection represents a legitimate proportion of the population.

3.4 Semi-structured interviews

Semi-structured interviews were conducted to support the findings from the contingent valuation survey. This combination of quantitative research with qualitative research, called a mixed-method approach, strengthens the results of this study. The goal of the semi-structured interviews was to gain more insight into the villagers perception on electricity; what do they see as benefits, to which uses will they put the mechanical and the electrical output. Is there a potential to expand the productive end uses (PEU's) and would villagers be willing to take on a loan for IWM-E installation.

The respondents for these semi-structured interviews were key stakeholders in both the village and the IWM-E project. This regards the owner of the mill or, in case when there is yet to be a mill, the owner of the selected land. Furthermore, the president of the community users group (CUG) was interviewed for this purpose. The IWM-E project prescribes the establishment of a community users group within the village and issues them to select one villager as president for the CUG who is the key informant between the village and the project organisations.

A design of the semi-structured interviews was made with fixed topics to answer a specific range of questions. An overview of the design can be found in appendix B. However, interviews were semi-structured and contained open questions which provides flexibility. This presented the opportunity to address subjects that came up on the spot. Furthermore, responses in semi-structured interviews can provide in-depth data that cannot be obtained through closed interviews.

4. Results

This chapter will elaborately describe and interpret the results from this study. The results are presented in four sub-sections. Firstly, the household characteristics of the respondents are presented. Secondly, income, expenditures and credit history are described. Thirdly, the willingness to pay, willingness to invest and ability to pay are assessed. And fourthly, the statistical analysis of variables is presented.

4.1. Household characteristics

This section describes the results regarding household characteristics obtained with the questionnaire from the contingent valuation survey. Furthermore, a detailed elaboration of the semi-structured interviews is presented. An interpretation of the results is made and discussed according to the sub-themes of this section. First, characteristics of the respondents are mapped in an overview. Second, current energy usage patterns are described and last an overview of the attitudinal survey is presented.

4.1.1 Respondents

The questionnaire started with gaining general insight into respondents information, regarding livelihood and household characteristics.

Overall, respondents of the questionnaire were the head of the house or the partner of the head of the house. Family size varied from 3 to 15 relatives and all respondents stated to have children. Information on the highest level of education of the head of the house was collected and is presented in Figure 6. The findings show that 59% of the respondents, which accounts for 20 households, did not receive any form of formal schooling. The 9% of respondents who attended college or university where all found in the same village, Khangsang, which was located close to the road and provided easy access to local transportation.

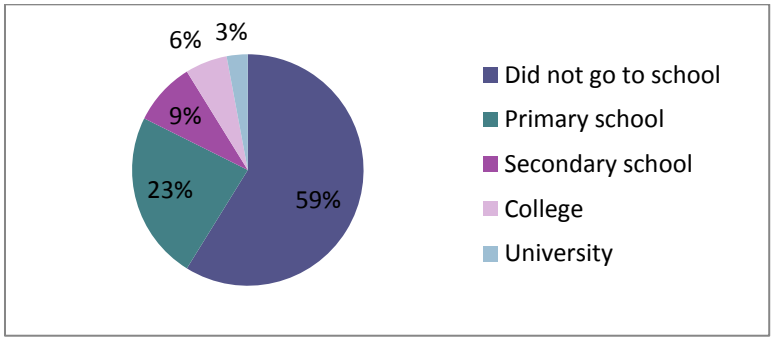

Figure 6: Highest level of education completed by the head of house. Sample size: 34

Access to a road and local transportation is important for the villages, since this provides them a connection to nearby settlements and markets. This is firstly important for their income, by means of selling livestock and agricultural products the majority of the respondents earn their proceeds. Secondly, this also provides them with needed supplies for their livelihoods, since 4 out of the 5 villages did not host a shop or market. And lastly, accessibility of a road is important for villagers as it is their connection to a broader possibility of schooling and labour opportunities. Therefore, the

remoteness of a village was assessed by gathering information on walking distance of the locals to the closest road.

The study shows that the remoteness of the villages varied considerably. The walking distance from the road to Jogimara was 2 to 3 hours for the local population, whereas the village of Khangsang was found directly at the roadside with the main highway leading south-east running past the houses. Figure 7 presents the walking distance from each respondent per village to the roadside. Differences between the villages are substantial as three villages have a walking distance varying from 0 to 30 minutes walking and the other sites were located at a distance further than 1 hour walking distance.

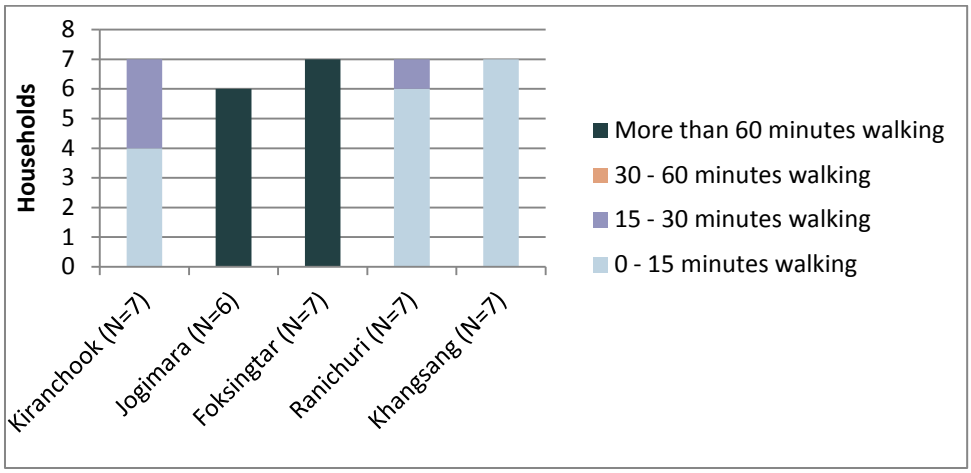

Figure 7: Distance from the house to the road, represented per village.

In addition to the distance from the house to the road, the distance from the house to the site of the improved watermill was mapped. This is another important factor for the IWM-E programme as it displays the distance that needs to be covered by the wire transporting the electricity. Figure 8 gives an overview of the walking distance from each respondent to the IWM-E site in the village. When no IWM was present, the proposed site by the technical staff from CRT/N was chosen as reference point. It becomes clear that distance to the mill is often not more than 15 minutes. Only 1 respondent, in Foksingtar, reported to live at a distance of 30 – 60 minutes walking from the mill.

This determines the extension length of the wiring. For example, in the case of Ranichuri the transmission cables throughout the village will constitute 2.5 kilometres.

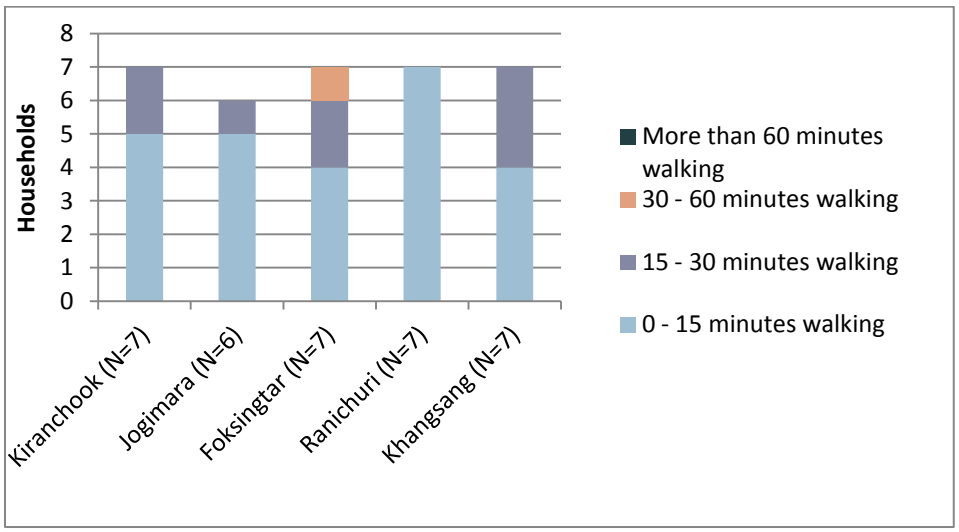

Figure 8: Distance from the house to the (potential) IMW-E site, represented per village.

4.1.2 Energy sources

The second parameter from the questionnaire aimed to map households current energy usage patterns and main sources.

The predominant energy supplies in the villages were derived from traditional energy sources, such as firewood and batteries. The households making use of batteries mainly utilised this energy for flashlights and powering a radio. Alternative energy sources used are mainly IWM-E, solar power and improved cook stoves (ICS). ICS is a popular household energy intervention in rural Nepal, reducing indoor air pollution (Singh *et al.,* 2012). One village, Foksingtar, was yet provided with electricity via IWM-E, since this was one of the sites from the pilot project in 2013. However, next to IWM-electrification several households generated electricity with small home solar systems. In total 21 respondents stated to make use of solar panels in their households.

Figure 9 gives an overview of the energy sources used by the respondents and the amount of households making use of this sources. Note that households can make use of different energy sources simultaneously.

Additionally, it is established that 15% of the households exclusively made use of traditional energy sources, whereas 85% of the respondents made use of a combination of traditional and alternative energy sources.

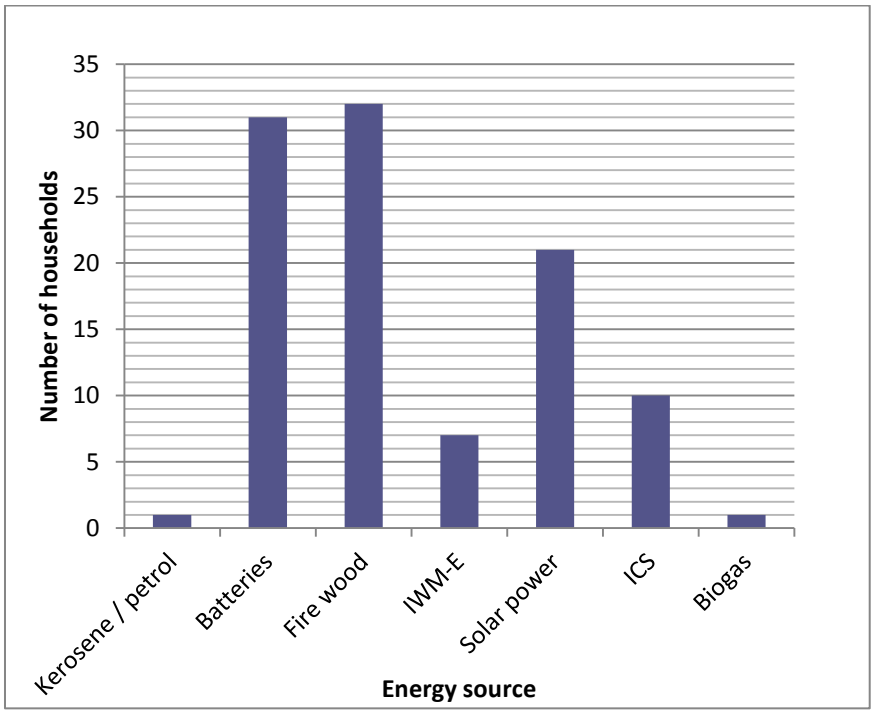

Figure 9: Major energy sources that households are dependent on. Note that households can make use of different energy sources simultaneously. Sample size: 34.

A further subdivision shows the consumptive uses of energy from the households. All households made use of energy for lighting the house and for cooking. A smaller share of the population owned a radio or mobile phone. Radio's were powered by use of batteries or solar power and mobile phones were charged with electricity from IWM-E or the small home solar systems.

Table 4 gives an overview of which energy sources were used per household for the respective consumptive uses. Note that the sample sizes per consumptive use differ, for example only 17

respondents stated to make use of radio and 25 respondents were able to charge their mobile phone at home.
Even though 21 households made use of solar power, for lighting, radio and mobile charging, most respondents recorded to wish to expand their use of electricity and have access to a higher output. Which can be established via IWM-E. This describes the potential yet to be gained by installation of IWM-E in the villages. Furthermore, electrification via IWM-E generates power for all households in the village and is not limited to individual houses.

Table 4: Main energy sources used for several domestic purposes

	Lighting (N=34)	Radio (N=17)	Mobile charging (N=25)	Cooking (N=34)
Firewood	-	-	-	34
Kerosene	1	-	-	-
Battery	7	15	-	-
IWM-E	7	-	7	-
Solar power	19	2	18	-

4.1.3 Attitudinal survey

The questionnaire also included an attitudinal survey, mapping the households attitude towards the access to and the use of electricity. This was measured with a likert-scale, ranging from 'strongly disagree', 'disagree', 'neither', 'agree' to 'strongly agree'. Respondents were given 8 statements, adjusted for households already making use of electricity (either from IWM-E or solar power) and households without access to electricity. Formulation of the statements was presented in first person writing. The following statements were asked:

1. *I am happy I can make use of electricity.*
2. *My life has improved since I have access to electricity.*
3. *Since I started using electricity the amount of electric applications in my house has increased.*
4. *Electricity is more reliable and durable than other options (e.g. kerosene / firewood).*
5. *Electricity is an affordable and useful technology for my house.*
6. *Electricity has a high safety level and is almost maintenance free.*
7. *If credit is needed for the IWM-electrification, I will take on a loan.*
8. *If credit is available to support me to start a micro-enterprise, I would go for this.*

An overview of the answers to the statements is presented in Figure 10.Figure 6 Strong positive answers are given to the first statement, proposing that people are happy to have access to electricity, and to statements 7 and 8. These last two statements proposed the respondents willingness to take on credit for respectively installation of IWM-E and starting a micro-enterprise. 30 households agreed with the first contention and 31 respondents agreed with the second. The highest negative responses were gathered from statement five, which stated that electricity is an affordable and useful technology for the household, whereas 11 respondents said to disagree.
The statements were tested for correlation to the respondents willingness to pay, to determine statistical relations or explanation of variance in stated preferences. The statistical analysis is further described in chapter 4.4 'statistical analysis of variables'. However, only one statistical significance was found, for the relation between the willingness to pay and statement 5. This relation describes

that a higher score for this statement, more agreement that electricity is a reliable and durable technique,
explains a higher stated amount for the WTP for electricity. Furthermore, no other statistical significance was found.

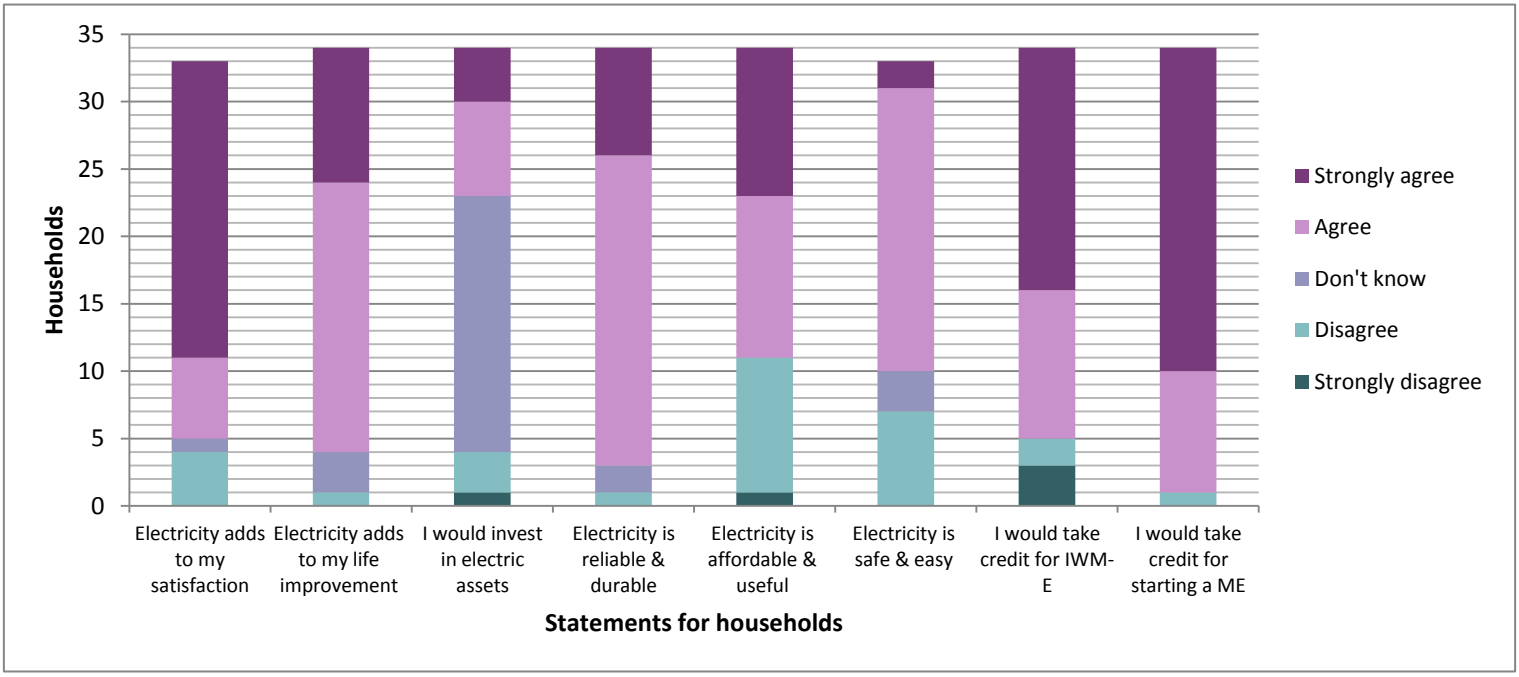

Figure 10: Overview of statements and answers from the attitudinal survey.

4.1.4 Semi-structured interviews

Next to the questionnaire, semi-structured interviews with key village representatives were conducted. On every visited site the president of the community users group (CUG) was interviewed. The CUG is responsible for keeping insight into the status of the watermill and the process of tariff collection within the village. These interviews provided more insight into the communities perception on electricity, the general benefits of electricity for households, the mechanical uses and electrical uses of IWM-E and the credit potential of the village.

Main reasons for the community to choose for IWM-electrification were that the project provides electricity in a short time-span and the high stability of electricity generated via IWM-E. Especially when compared to the national grid, which knows long hours of load-shedding when there is no electricity available, IWM-E has the potential to provide day-round electricity. Furthermore, IWM-E has the added benefit of mechanical power, next to the electric output from the watermill. Creating more opportunities for the community to work their products, like hulling and grinding processes. For which they formerly did not have a possibility.

The predominant benefits for the community from IWM-E were the elaborate end-use possibilities. Naturally, access to electricity enabled the villagers to light their house, power small electric devices and charge their mobile phones. Additionally, all interviewed villagers expressed the will to start or expand micro-enterprises within their community. The output from IWM-E yields the potential to operate the needed machinery and provide sufficient hours of electricity. Micro-enterprises mentioned entail poultry-farming, tailoring, copy-and-printing, carpentry, milk-cooling and setting up shop with cooled beverages.

Mill owners and presidents of the CUG were asked for the community perception on taking on credit. There appeared to be no negative perceptions and general statement was that if credit could be distributed and the purpose of this money is meaningful, then there are no objections for taking on a loan. An overview of the design of semi-structured interviews can be found in appendix B.

4.2 Income, expenditures and credit

This section describes the results regarding income distribution, expenditure patterns and credit history of the respondents. The results were obtained with the questionnaire from the contingent valuation survey and their implications are discussed. Furthermore, a comparison between income and expenditures is made.

4.2.1 Income distribution

Households income is mainly dependent on the economic activity of the respondents, meaning the type of employment they practice. From the 34 respondents a majority of 32 households main economic activity was subsistence farming. They owned private or family land, cultivate vegetables and kept livestock. However, in order to generate additional income, in some cases one or more household members pursued other means of employment.

Figure 10 shows the income generating economic activities of the households, represented per village. Apart from subsistence farming, part-time labour is the predominant form of employment for this population. All respondents from the remote village Jogimara revealed to participate in part-time labour at least once a year. One or two members of the household would leave the village for approximately a month and perform part-time labour at a nearby market. This would support them with a considerable amount of money to cope for some time.

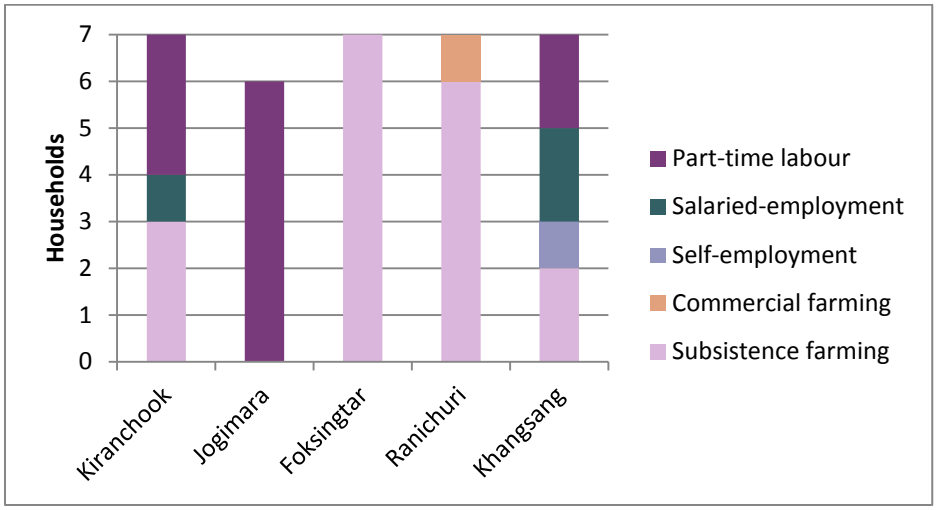

Figure 10: Overview of the income generating economic activities of the households, represented per village.

Next, the income of the households, mainly determined by the type of labour, was questioned in the survey. Nine income categories were designed and respondents could fill in to which income category they belonged. Income was divided into categories in order to safeguard confidential information, which respondents might be reluctant to share. The respondent is more likely to state a realistic estimation of monthly income when moderate categories are presented. Furthermore, the

answers of monthly income are based upon the regular labour income from the respondents. Since part-time labour is an occasional and irregular employment and is therefore not accounted for in the monthly income. The findings of respondents income are presented in Figure 11.

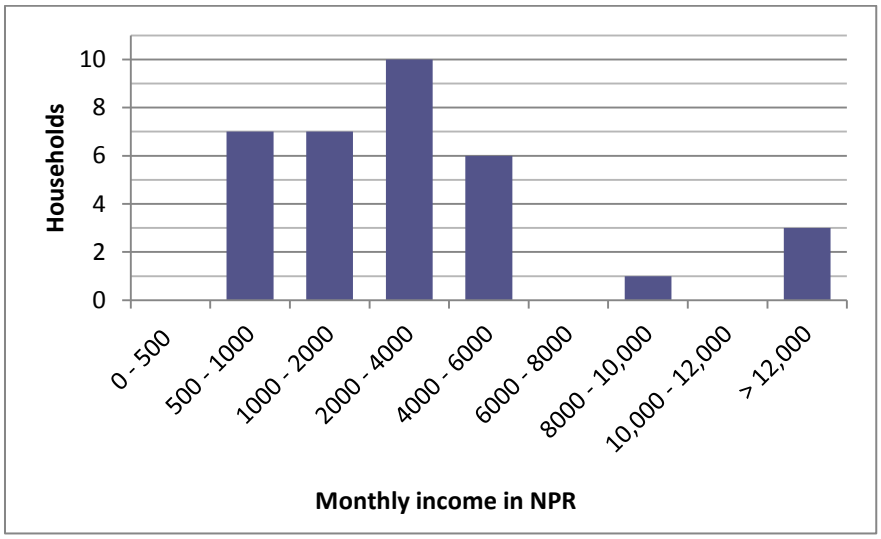

Figure 11: Households monthly income in Nepali Rupee (NPR)

As can be seen, the majority of the respondents earns a monthly income that ranges from 500 NPR to 6000 NPR, which is a wide range. The mean amount of monthly income is 2000 to 4000 NPR and this is also the mode, the most frequent given answer in the survey. Additionally, the average monthly income from farming was mapped. The mean monthly income from agriculture is 1000 to 2000 NPR. Three households are found that earn more than 12,000 NPR monthly. These households owned a private enterprise or were enrolled in salaried employment (as teacher). All three of these households were found in the road village Khangsang.

Furthermore, extra proceeds in the form of remittances or kind were elicit with the CVS. This showed that 6 out of 33 households receive remittances and only 3 out of 34 households receive income in kind. These types of proceeds were not translated into monetary values.

The income results from the questionnaire reveal that the majority of the respondents are subsistence farmers and earn only a small income from this activity. Approximately 25% of the population conducted occasional part-time labour in order to suffice in higher income. The majority of respondents earned between 2000 and 4000 NPR monthly. This is well below the country average. According to the World Data Bank (2014) the annual gross national income (GNI) per capita in Nepal in 2012 was 700 U.S. dollars. When converted to Nepali Rupee this accounts for 5530 NPR monthly (wisselkoers.nl, 2014[1]). From this can be concluded that the gross population from this survey has a relative low monthly income compared to national average. Therefore, having a limited spending budget.

4.2.2 Household expenditures

To determine household expenditure, six main categories were developed following an expenditure theme:

1. Food, water, clothing
2. Energy sources: kerosene, fire wood, batteries, candles

[1] Currency conversion date: 15 – 06 – 2014 .

3. Household supplies, work supplies, school supplies
4. Electric assets: lights, radio, tv, mobile phone
5. Institutional payments (e.g. house, property)
6. Other

The respondents were first asked to rank these categories from high highest amount of money spent monthly to lowest amount. Then, respondents were asked to indicate absolute amounts of money spent per category. The ranking showed clearly that most money is spend on category 1 [food, water, clothing] and second on category 3 [household supplies, work supplies, school supplies]. Hardly any households had regular payments for category 5 and 6, respectively five households stated institutional payments and three households indicated to have monthly other expenditures.

An overview of the expenditures in NPR of the main categories, 1 to 4, is presented in figures 12 to 15.

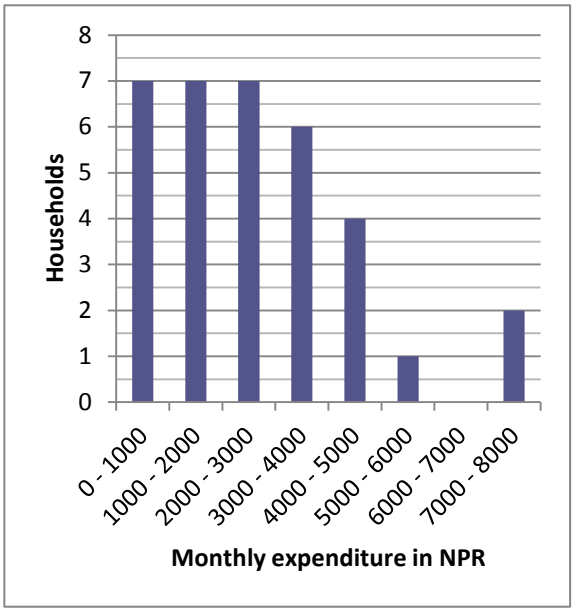

Figure 12: Food, water, clothing

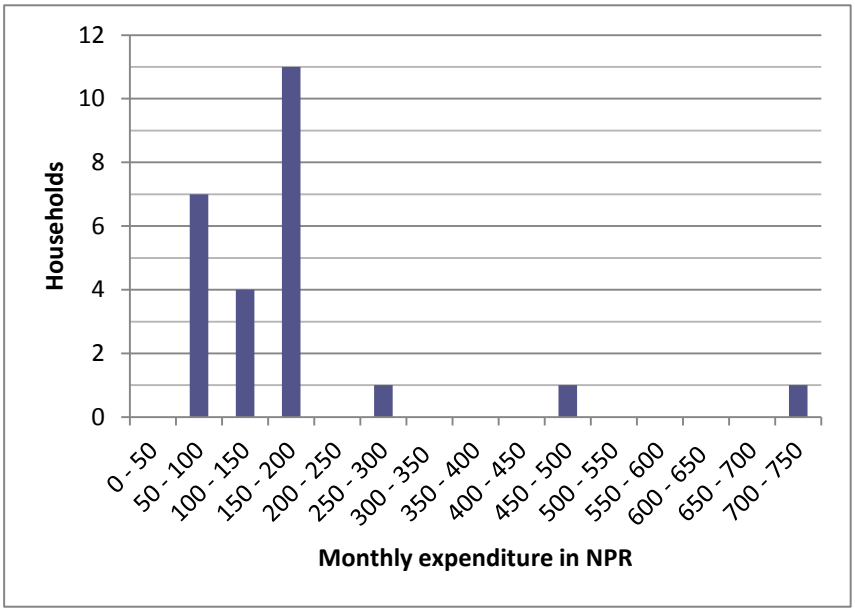

Figure 13: Energy sources

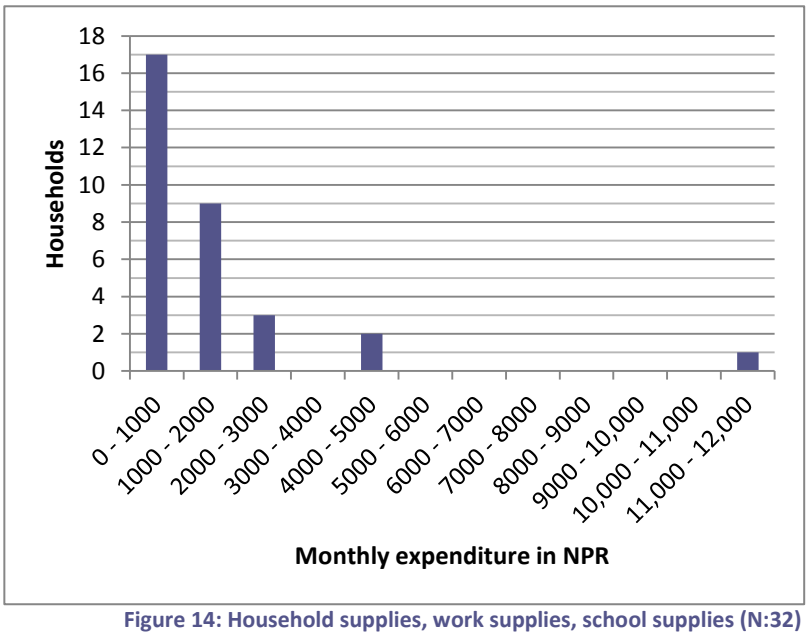

Figure 14: Household supplies, work supplies, school supplies (N:32)

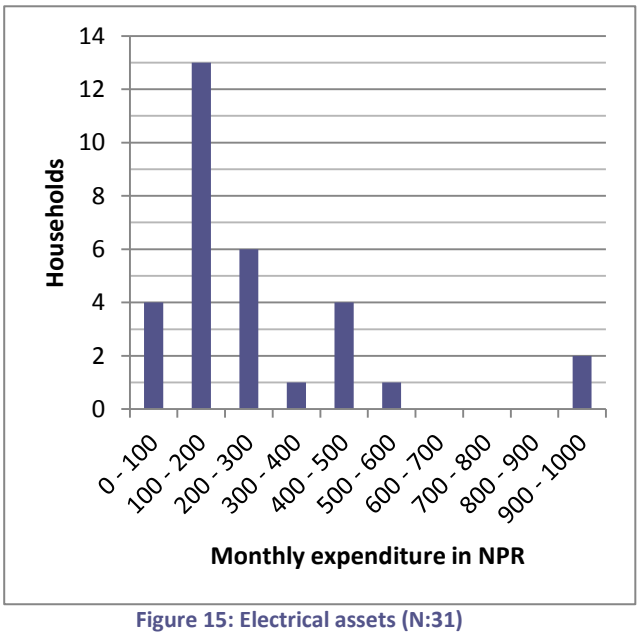

Figure 15: Electrical assets (N:31)

Note that the axes vary per figure, due to scalability of the figures. The x-axis depicts the state amount in NPR spend on that category and the y-axis shows how many households spend that amount monthly.

Figure 12 shows the category [food, water, clothing]. The mean and the mode of the monthly expenditures in this category is 3000 NPR, but with a standard deviation of 2000 NPR. Clearly, there is much variation between the amounts, the lowest is 500 NPR and the highest is 8000 NPR monthly. In this category food is the main expense. Since all households said that they do not pay for water, but they get it directly from a nearby stream. The sample size for households spending money in this category is 34.

The monthly expenditures on [energy sources] account predominantly for batteries (figure 13). The average amount is 200 NPR with a standard deviation of 150 NPR. The mode is 200 NPR and the range of expenditures reaches from 65 NPR to 750 NPR. The sample size for households spending money in this category is 26. Furthermore, six households said to spend money on firewood on an annual basis, the remaining households said to never have to spend money on firewood.

Figure 14 presents the monthly expenditure on [household supplies, work supplies, school supplies]. This includes tuition fees for school. The mean monthly expenditure is 1700 NPR, with a standard deviation of 2000 NPR. This is due to the extreme outlier of 12,000 NPR monthly. This outlier is not a bias since this households has children receiving relatively expensive education and the amount is correct. When this outlier is disregarded, the mean is 1400 NPR with a standard deviation of 1100 NPR. The lowest amount is then 500 NPR and the highest is 5000 NPR. The mode for this expenditure is 1000 NPR. The sample size for households spending money in this category is 32.

Figure 15 presents the monthly expenditures on [electrical assets], this accounts mainly for the costs for recharging credit for mobile phones. General perception of households is that the expenditures for a mobile phone are high, but almost every household appears to own at least one mobile phone. The mean monthly expenditure is 300 NPR with a standard deviation of 200 NPR. The most frequent amount is 200 NPR and the expenditure in this category ranges from 50 NPR to 1000 NPR monthly. The sample size for households spending money in this category is 31.

Additional expenditures were tariff payment for electricity via IWM-E, which was already operational in the village of Foksingtar. Their tariff setting was decided by a meeting of the community users group. They decided that households that have 6 CFL light-bulbs or less pay 150 NPR/month and households that own more than 6 CFL light-bulbs pay 300 NPR/month. There is only one household interviewed that paid the tariff of 300 NPR, the owner of the IWM-E and the president of the users committee. Furthermore, eight respondents said to have additional expenses. These consisted of payments for house, property, health care, marriage and other cultural ceremonies. The range of these expenses runs from 15 NPR to 1000 NPR monthly.

4.2.3 Discussion of income and expenditure comparison

The main expenses for the households are food, clothing, household supplies, work supplies and school supplies. The latter also includes tuition fees. Water was not an expense for these households as it is commonly gathered from nearby streams and distributed for free. Other categories were ranked having substantial lower costs, like energy sources, electricity, electric assets and additional or occasional expenses.

The high costs for food can be regarded rather unconventional, since the majority of the population was farmer, growing various crops and owning livestock. Moreover, their land was either private

owned (73%) or family owned (27%). However, the survey was unable to elicit the reason for this observation. And the stated monthly amount spent on the category [food, water, clothing] ranged from 500 NPR to 8000 NPR. This makes this category the absolute highest cost item for households. When the income was compared to the amount spent on food and clothing, the calculation did not always add up. 10 out of 34 households indicated to spend more money on this category then the amount they earned as income monthly. The reasons for this were researched with the semi-structured interviews and follow-up questions for the respondents. Three potential explanations were found. Firstly, this is due to the part-time labour which generates occasional income for the households. Which was mostly not incorporated in their answers to the amount of regular monthly income earned. Therefore, actual spending budget of the households conducting part-time labour was higher than the given income amount in the questionnaire. Secondly, villagers whose economic activity was solely farming indicated to sell extra livestock when ends were tight. Permitting them to be able to pay for all necessary expenses. The third reason for this bias is a lack of financial insight of the respondents. Interviewed household did not hold a personal administration regarding their income or expenditures and all money flows are in cash. They often did not have a clear overview of realistic monthly expenditures per category and some were unable to provide accurate answers. It was difficult for the interviewers to prevent this bias, since there appeared no easy or fast way around the respondents lack of knowledge.

Additional to a comparison between income and the most cost expensive category another calculation was made. The equation of income versus total monthly expenditures proved that 25 out 34 households indicated to spent more money than their income could allow. This accounts for 74% of the respondents. These 25 respondents were found throughout all five villages. The reasons for this mismatch are similar to the findings mentioned above for the category [food, water, clothing]. Meaning the disregarded effect of part-time labour on the income, selling livestock when needed and a lack of personal financial insights. Moreover, a ranking exercise was conducted in the questionnaire to verify the order of amounts stated for expense categories. The majority of results from this ranking exercise revealed a similar pattern as expense amounts. It can be concluded from this that the respondents do have a realistic view on which expense categories cost more than others.

The category [energy sources] provided one distinctive outlier, whose monthly expense was 1700 NPR. The high expenditure on energy sources is explained by the petrol this respondent used for his motorbike, he is the only respondent that makes use of a motorized vehicle and the high expenditure is consistent with the costs for petrol. Since the aim of the questionnaire was to elicit domestic expenditures on household energy, this outlier was discarded from the analysis.

4.2.4 Credit history

The following set of parameters measured in the CVS mapped credit history of the respondents. The credit history and perception of taking on a loan was measured in order to determine the potential of incorporating a credit component into the financial scheme.

The survey found that almost half of the population already had made use of credit in the past, and therefore was familiar with the concept and debt repayment. 19 out of the 34 households had taken on a loan in the previous 5 years. The main reason for this loan was the purchase of livestock, accounting for 13 respondents. Other reasons were to build a house, for education, for a marriage and for daily life. Several households stated multiple purposes for the credit. The range of credit

varied from 5000 NPR to 200,000 NPR. The most frequent amount was 20,000 NPR, lent by 4 households. Only 4 households had took on credit above 50,000 NPR. Table 5 gives an overview of credit history of the 19 households, showing the amount of credit in NPR, the number of households, interest rates and loan purposes.

Table 5: Credit history of households. Note that '-' means 'answer unknown'.

Amount of loan (NPR)	Number of households	Interest rate (%)	Purpose of loan
5000	1	-	Daily life
10,000	1	6	Purchase livestock
12,600	1	12	Purchase livestock
14,000	1	12	Purchase livestock
15,000	1	-	Wedding
18,000	2	12	Purchase livestock
20,000	4	12 / 24	Wedding Purchase livestock
25,000	2	12	Purchase livestock
30,000	1	-	Agriculture
50,000	1	24	Installation IWM
100,000	2	-	Purchase livestock House construction
150,000	1	24	Purchase livestock Daily life
200,000	1	24	Education, Wedding Purchase livestock

As shown in Table 5, interest rates varied from 6% annually to 24%, however not all organisations employed time constraint on the repayment amounts and years. Most credit facilitators were local organisations. Reasons for varying interest rates were not found with the questionnaire. Villagers always paid interest rate and when there was no time constraint, respondents redeemed money when they were able to.

Additional to credit history, respondents perception on taking on a loan was measured in several ways. Respondents were asked if they were willing to take on a loan for IWM-E installation and 97% of the respondents answered to be willing, whereas 3% said not to be willing. Then the question was asked to what extent they agreed with the following statement: "If credit is needed for the IWM-electrification, I would take on a loan". Respondents had to choose from the following answers, strongly disagree; disagree; neither; agree; strongly agree. In Figure 16 the occurrence of the answers is depicted. 53% of the respondents strongly agreed with the statement and added together 85% of the respondents answered to either agree or strongly agree.

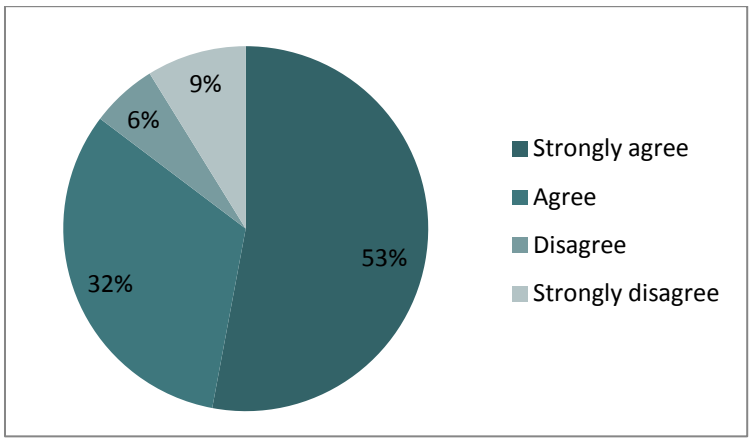

Figure 16: Answer to statement "If credit was needed for the IWM-electrification, I would have taken on a loan". Sample size: 34

The overall perception of households taking on a loan was positive, no objections were registered as long as the purpose of the loan was regarded useful by the villagers. The amounts and interest rates of the credit histories varied considerably. Moreover, the population of respondent with former loans consisted only of 19. Accordingly, no further calculations were considered justified with these results to represent to true population of households.

4.3 Willingness to pay, willingness to invest and ability to pay

This section describes the parameters willingness to pay and willingness to invest from the CVS. Moreover, an assessment of the ability is made based upon income and expenditure data from the respondents. Additionally, an overview of the WTP, WTI and ATP is presented.

4.3.1 Willingness to pay

The main objective of a contingent valuation survey is to elicit a willingness to pay (WTP) and a willingness to invest (WTI) from the respondents. The WTI represents the amount that households would like to invest in the installation of the project. Apart from installation costs a monthly contribution for use of electricity is necessary. The WTP accounts for the monthly payment for consumptive use of the electricity from the IWM-E, which is called tariff. And when a credit component is added to the financial scheme of IWM-E installation, the monthly payment will consist of tariff and debt repayment. Therefore, three scenarios were designed and the WTP for all was measured with the questionnaire. The households were asked to state a WTP amount for the following 3 scenarios:

- Tariff payment for lighting the house and charging of a mobile phone
- Tariff payment for lighting the house, charging a mobile phone and powering a radio and television
- Tariff payment for all of the above and repayment of the (potential) credit

The amounts that the households were willing to pay are presented in Figure 17.

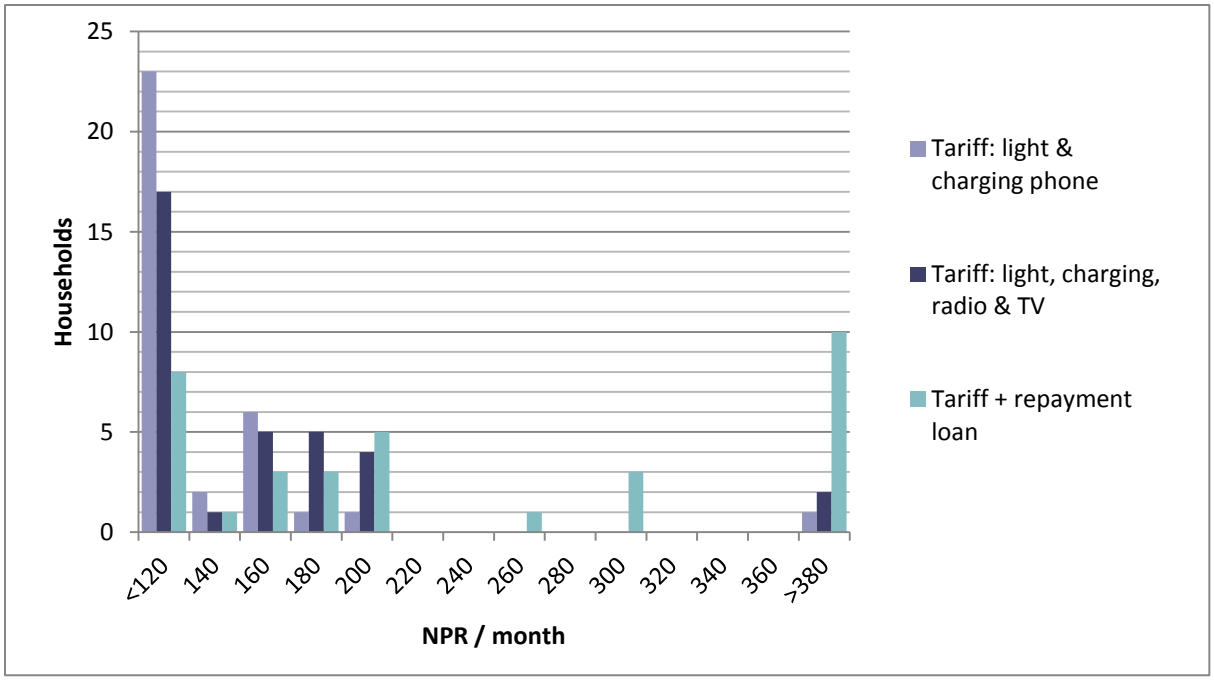

Figure 17: Overview of households willingness to pay per month for three scenarios, in NPR. Sample size: 34

The mean for the first scenario, where households only pay tariff to light their house and charge their phones, was 140 NPR / month, but the most frequent given answer was 120 NPR or less. The mean for the second scenario is 160 NPR, however also the mode here is 120 NPR or less per month.

The mean for the last scenario, where households pay tariff for the usage of electricity and additionally repay credit debt, was 240 NPR monthly. Additionally, as can be seen in Figure 17, the most frequent answer for the third scenario was monthly 380 NPR or more. This third scenario presents the potential for the incorporation of a credit component and shows the willingness of the respondents to make higher payments when debt needs to be repaid.

As previously shown, 97% of the respondents said to be willing to take on a loan for IWM-electrification. Following that question their preference in repayments years for credit was measured. Figure 18 presents the amount of years. The mean amount is 4 years of credit repayment, however the mode is more than 5 years.

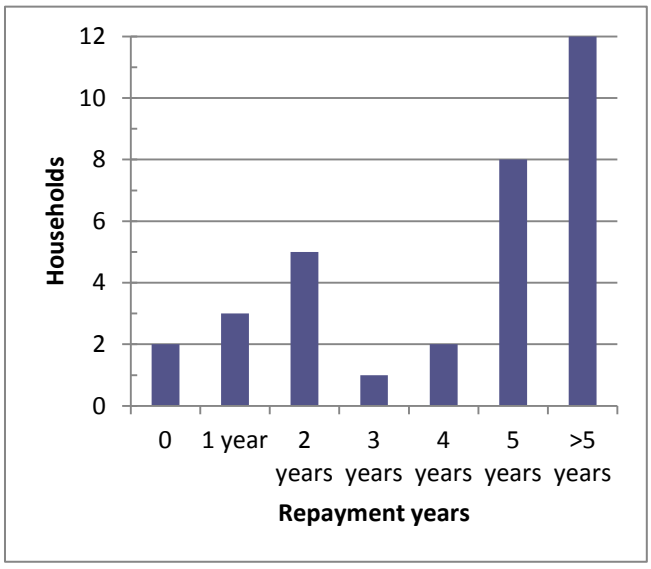

Figure 18: The amount of years that households are willing to repay for IWM-E credit. Sample size: 33

The WTP survey shows that overall the respondents were willing to pay a considerably higher amount for tariff in combination with loan repayment. On average this was 240 NPR. Suggesting there is a potential to increase the monthly expense for IWM-E for the households, when a credit component is introduced. Furthermore, the most frequent amount indicated for this scenario was 380 NPR or more on a monthly basis. Which was elaborated on by some respondents stating to very eager to start a business and pay well for electricity.

4.3.2 Willingness to invest

Furthermore, respondents were inquired about the willingness to invest in installation of the IWM-E. This is an one-time investment to cover a share of the upfront costs of the project. The respondents were presented a choice card with options they could choose for WTI. This choice cards was incorporated into the questionnaire, which can be found in appendix A. The range from the choice card was ≤ 1000 NPR to ≥ 14,000 NPR, with consecutive steps of 1000 NPR. As can be seen in Figure 19, only 5 options were selected by all 34 respondents. Following from these answers, the mean amount of WTI was 3000 NPR. However, the most frequent given answer is a WTI of 1000 NPR or less.

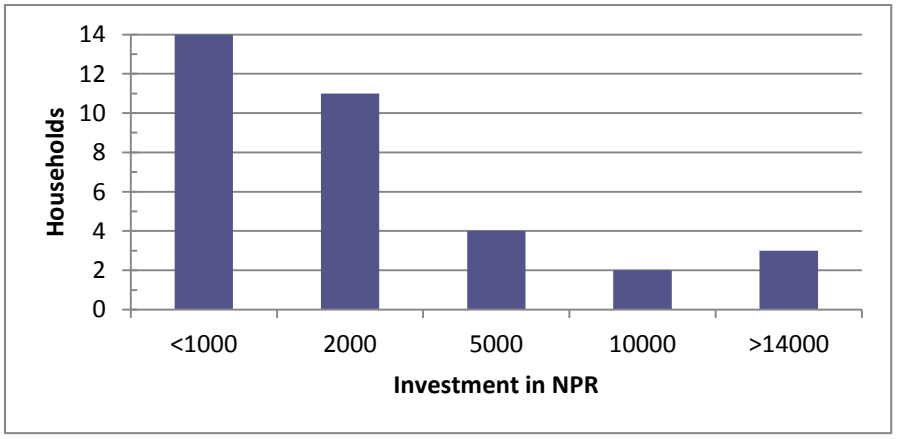

Figure 19: Overview of households willingness to invest in installation of the IWM-E, in NPR. Sample size: 34

The mean amount given for WTI was is substantially higher than the most frequent given answer. No underlying explanation for this was found with the CVS. However, a slight relation appeared to exist between the income of the household and the stated WTI. From all variables mapped in the regression analysis, this pair proved to have the strongest connection. The correlation coefficient, describing the trend of these variables, was 0.58. Indicating a moderate positive relation between income and the willingness to invest of the households in IWM-electrification.

4.3.3 Ability to pay assessment

An assessment of the ability to pay (ATP) is based on the current expenditure on energy sources and electricity of the respondents. The share of energy expenditures is calculated as percentage from their individual total income and their individual total expenditures. The range of current energy and electricity expenditures runs from 0 NPR to 750 NPR per month.

First, all households energy and electricity expenditures were mapped to all households income. Then a calculation was made to determine which percentage of monthly income was spent on energy. An overview of the calculation is given in Table 6:

Table 6: Example calculation of income share that is spend on energy and electricity, described for 1 respondent

Electricity expenditure (NPR)	Energy expenditure (NPR)	Total energy + electricity expenses (NPR)	Monthly income (NPR)	Percentage of income spend on energy and electricity (%)
150	200	350	3000	11.67

When all percentage were calculated the average was measured and recorded a mean of 12% of income which is spent on energy and electricity.
Subsequently, the average of all income was determined to calculate 12% of this amount. From the survey was elicited that the mean and most frequent regular monthly income under the respondents was 2000 to 4000 NPR. Since this is a relative broad category an average of 3000 NPR/month is taken as a representative amount for the population. When 12% of this income is potentially spent on energy sources, this accumulates to 360 NPR monthly.
Therefore, when the ability to pay for energy and electricity is based upon the share of their income, the respondents ATP is 360 NPR per month.
Additional to the share of income spend also the share of total expenditures that is spent on energy and electricity was calculated. The calculation was designed in the exact similar way as for the first ATP-assessment (Table 6).
Found was that on average 5% of the total expenditures was spent on energy and electricity. Next, the average monthly expenditure of the respondents was calculated, which was 5181 NPR. When taken 5% of this amount we find a potential amount for energy sources of 260 NPR monthly.
Therefore, when the ability to pay for energy and electricity is based upon the share of their total expenditures, the respondents ATP is 260 NPR per month.
Accordingly, a range for the ATP can be established. As depicted in Table 7, running from 260 NPR to 360 NPR per month. These amounts seem reasonable and tolerable by the respondents from this population. However, the detail of used variables needs to be kept in mind. These calculations are based on expenditures which constitute mainly of energy sources other than electricity. It can be concluded can be that these sources will not be completely substituted when households gain access to electricity. Since, the village which already made use of IWM-E has not discarded the use of traditional energy sources.

Table 7: Assessment of ability to pay, based upon the energy expenditure as share of income and of total expenditure.

	Total amount (NPR)	Share that is spent on energy	Ability to pay (NPR)
Energy expenditure as share of income	3000	12 %	360
Energy expenditure as share of total expenditure	5181	5 %	260

When willingness to pay and ability to pay for IWM-E are combined, the financial capacity from the households spend on electricity ranges from 240 NPR to 360 NPR per month.

4.4 Statistical analysis of variables

This section presents the statistical analysis of variables from the questionnaire. Statistical significance of variable pairs was tested and subsequently a regression analysis and correlation coefficient analysis was conducted.

4.4.1 Statistical significance

The main parameters for the CVS are: income, expenditures, willingness to pay and willingness to invest. These variables were measured with the questionnaire and tested for statistical significant to show any relations. Additionally, a regression analysis and correlation coefficient analysis was conducted for the same set of variables. The results are presented in Table 8. The table is divided in variable pairs that did show a statistical significance and variables that did not. Furthermore, for the variable WTP the scenarios 1 and 3 were measured. Scenario 1 describes monthly tariff payment for only electricity to light the house and charge a mobile phone. Scenario 3 describes a more comprehensive electricity provision in combination with a monthly debt repayment.

As shown in the table, only variable pairs 1 to 3 showed a significant relation. Statistical significance was employed when the *P-value* was below a value of 0.05. The analysis found a significance between WTP (scenario 1) and expenditure on energy sources, between WTI and income and between WTP (scenario 3) and the statement 'Electricity is an affordable and useful technology for my house'.

4.4.2 Regression analysis and correlation coefficient

In total 15 dependent and independent variables were measured in the statistical analysis, which is shown in Table 8. The correlation coefficient was mapped to show the direction and the strength of a linear relationship between variables. Moreover, a regression analysis was conducted to predict how the dependent variable changes when the independent variable is varied.

Only three variable pairs suggested a statistical significance and showed an R-square between 0.25 and 0.30. The highest found R-square was for the variable pair of income and willingness to invest. This means that 30% of the variance in WTI is explained by variation in income.

These three compared variables also provided the highest scores for the correlation coefficient, all of them describing a positive relation. However, no higher coefficient than 0.548 was found in all tests. Which accounts for a moderate relationship. No strong relations were found based on the correlation coefficient.

The lack of relation between the effect of income and the stated preference of WTP is not entirely consistent with the literature. So is the income effect of CVS, as defined by Horowitz & McConnell (2003), regarded as a measure of the validity of the survey. When no positive income effect is found it is considered that respondents did not seriously consider their answers (Schläpfer, 2006). However, the application of this effect is doubtful in light of the before mentioned possible biases in income and expenditure data from the households.

Table 8: Statistical analysis: significance, regression analysis and correlation coefficient.

	Regression analysis & correlation coefficient				
	Dependent variable	*Independent variable*	*R-square*	*P-value*	*Multiple correlation coefficient*
		Statistical significance between variables			
1.	WTP (1)	Expenditure [energy sources]	0.250	0.003	0.450
2.	WTI	Income	0.300	0.0009	0.548
3.	WTP (3)	Electricity is affordable and useful	0.272	0.002	0.523
		No statistical significance between variables			
4.	WTP (3)	Income	0.006	0.666	0.078
5.	WTP (3)	Expenditure [energy sources]	0.089	0.092	0.298
6.	WTP (3)	Expenditure [electric assets]	0.0006	0.894	0.024
7.	WTP (3)	Expenditure [food, water, clothes]	0.074	0.125	0.272
8.	WTP (1)	Income	0.050	0.213	0.223
9.	WTP (1)	Expenditure [electric assets]	0.085	0.099	0.292
10.	WTP (1)	Expenditure [food, water, clothes]	0.0003	0.915	0.019
11.	WTP (3)	Electricity adds to my satisfaction	0.020	0.431	0.142
12.	WTP (3)	I would invest in electrical assets	0.061	0.158	0.248
13.	WTP (3)	Electricity adds to life improvement	0.114	0.051	0.337
14.	WTP (3)	Electricity is reliable and durable	0.002	0.823	0.040
15.	WTP (3)	Electricity is safe and easy	0.020	0.425	0.141

5. Discussion

This chapter will present a discussion of the set-up of the survey. It will elaborate on site specificity of the case-studies, record limitations and strengths of the research.

5.1 Site specific variations

For the main analyses of this study the five study site were combined and treated as one population. However, qualities of the sites varied considerably amongst each other and are described here. The most distinctive difference between villages is the income deviation.

Three distinct outliers were found in the last village, Khangsang, where three respondents earned a monthly income above 12,000 NPR. From follow-up questions it became clear that one respondent even received 18,000 NPR monthly, with his profession as teacher. These amounts are completely out of range compared to the income of the majority, which reaches a maximum of 6000 NPR. The village of Khangsang was located directly at the roadside. This appears to have several benefits for the development of the community. They have easier access to other nearby settlements and local transportation. Therefore, the overall education level was higher than in the other four villages and more respondents were salary-employed in varying branches. Furthermore, many travellers passed by on the road daily, which led to the possibility for the villagers to set up shop and generate income via micro-enterprises. This higher income allowed several respondents to state much higher amounts that they were willing to pay or invest for IWM-electrification.

This access to nearby settlements, a market site and local transportation was another very differing quality amongst the villages. As mentioned, a highway ran directly through the village of Khangsang. On the contrary, the villages of Jogimara and Foksingtar were so remote, that the walking distance to the most nearby road was respectively 2.5 hours and 2 hours. This influences the potential of setting up a micro-enterprise and the access to elaborate resources or schooling, which effects income of the villagers substantially. The most remote village was Jogimara and here we viewed that all interviewed respondents conducted part-time labour. For this labour they left home once or twice a year for at least 1 month, leaving a smaller portion of the households taking care of the same workload on the farm. However, this labour appeared necessary to suffice in income for the household.

5.2 Limitations to the study

Concerning methodological issues, one central point of discussion is that the questionnaires were conducted by three different interpreters. The questionnaire was thoroughly discussed with all interpreters in order to streamline the format of questioning and to ensure that all interpreters comprehended the questions. Additionally, all interviews were carefully supervised. Two main interpreters were appointed and for village 1 to 4 all respondents from that concerning village were interviewed by the same interpreter. However, due to time-constraints, two questionnaires in the last village were conducted by a third interpreter. This variation has an effect on the standardization of the way questions were asked and the answers received. A constant quality could not be guaranteed this way. Furthermore,

several respondents spoke in a native language which was unfamiliar to the interpreter. A third party from the local site helped translating the questions for a second time in order to get answers from the respondent. It is difficult to assess if information got lost or misinterpreted in this double questioning process.

Regarding the financial insights of the respondents it becomes clear from the survey that the majority of the respondents lack a clear personal overview. It turned out that 74% of the respondents stated a lower regular monthly income than their expenditures. This is in part explained by a lack of financial administration of the households, due to not being salary-employed or having a bank account. Moreover, respondents indicated to conduct occasional part-time labour to earn additional income or resorted to sale some of their livestock for money provision. This yields a potential to explain how their expenditure could be higher than regular income and present us an amount close to reality. However, some doubts are expressed towards the accuracy of the stated amounts. Therefore, caution needs to be taken when employing the ability to pay range of 260 NPR to 360 NPR. Since all calculations of the assessment of the ATP are based on these data.

Furthermore, the sample size of the population is rather small. Both new IWM-E sites and both potential IWM-E sites were surveyed, additional, questionnaires and interviews were conducted in one of the four villages from the pilot phase. This adds up to more than half of all the current villages involved in the IWM-electrification project being incorporated in this study. However, these 8 villages constitute of approximately 200 households of which a population of 34 was randomly chosen. The reason for this sample size is, firstly, a time constraint for the field survey and, secondly, that the houses in the villages were scattered throughout a large area and sometimes rough terrain. Therefore, it was chosen to interview around 30% of the involved IWM-E households per visited site. A goal which was met in all villages.

5.3 Strengths of the study

A contingent valuation survey is a proven and sound technique for measuring stated preference choices like WTP and WTI (Breidert *et al.,* 2006; Wedgwood & Sansom, 2003). This underpins the methodology used for this survey. Furthermore, the blending of quantitative research with qualitative research leads to a mixed-method approach, improving the reliability of the data.

No difficulties with respondents were encountered in collection of field data, all respondents were cooperative and open. Moreover, conducting field research in comparison to performing a meta-analysis helps to improve the understanding and interpretation of the results by the researchers. It offers an accurate context of the study sites and generates the potential to adapt to unforeseen factors hindering the survey.

6. Conclusion and recommendations

This chapter will present the main conclusions from this research and an answer to the research question is provided. Furthermore, recommendations to the IWM-E project are made and possibilities for future research are explained.

6.1 Research conclusions

In this research study, the financial capacity of the households from selected IWM-E sites is explored. The objective was to assess the willingness to pay, willingness to invest and the ability to pay of the respondents regarding IWM-E installation. In order to explore the potential of incorporation a credit component into the financial scheme. The research question addressed is *'What is the financial capacity of rural households in the IWM-E programme to increase payment contribution to the installation costs?'*.

A contingent valuation survey was conducted to measure the financial g capacity of the households. Firstly, WTP and WTI were questioned to measure the stated preference of the respondents. The average WTP, for the scenario of tariff for consumptive use plus loan repayment, was 240 NPR per month. The average stated amount for WTI was 3000 NPR. Secondly, an assessment of the ATP was made based upon the expenditures on energy as proportion of the total monthly expenditures and the total monthly income. This provided a range for ATP from 260 NPR to 360 NPR per month. See Table 9 for an overview of these figures.

When willingness to pay and ability to pay for IWM-E are combined, the financial capacity from the households from this survey amounts to 240 NPR to 360 NPR per month.

Table 9: Summary of WTP, ATP and WTI of respondents of the contingent valuation survey

	Expense	Amount in NPR
1.	WTP (for tariff + loan repayment)	240
2.	ATP (for tariff + loan repayment	260 – 360
3.	WTI (for IWM-E installation)	3000

Furthermore, this survey aimed to map the attitude of the rural community towards electricity and credit history. Findings from the attitude study showed that overall the respondents are happy to have access to electricity, are of the opinion that their life will improve with electricity and that it is a reliable and durable technology for their household. Moreover, the majority showed prepared to take on credit for IWM-E or to start a micro-enterprise with use of electricity.

The credit history survey showed that 19 out of the 34 respondents had taken on a loan in the past and were familiar with debts and paying interest. 97% of the population stated bluntly to be willing to take on a loan for the installation of IWM-electrification.

6.2 Recommendations

When the broad range of the financial capacity of the households and the willingness of the respondents of taking on a loan are taken together, we can conclude that there exists a realistic potential to increase the monthly payments

made by the villagers. The second step is to explore the possibilities of credit facility in Nepal. Which institutions exist and what is their operating area? Which requirements are set to the distribution of credit and what are the interest rates? When this information is known, it can be compared to the financial range found in this study. Simultaneous to this survey, a study on credit facilities in Nepal, with regard to the IWM-E project, was conducted. Combining the results from these studies can provide a comprehensive insight into the potential and range of incorporation of loans for the community towards IWM-electrification.

An advice on the potential of a credit component in the financial scheme will be provided, in close collaboration with V. Oonk, to SNV and GIZ. This will aid the further up-scaling of rural IWM-electrification in Nepal. When recapping on the analytical framework for a planning process, this research fulfilled step 3 and 4 of the process (Wedgwood & Sansom, 2003). The framework is shown in Figure 20 and highlights the position of finalisation in the decision-making process. Step 6 to 8 enable SNV and GIZ to conclude the project with a more sustainable financial scheme.

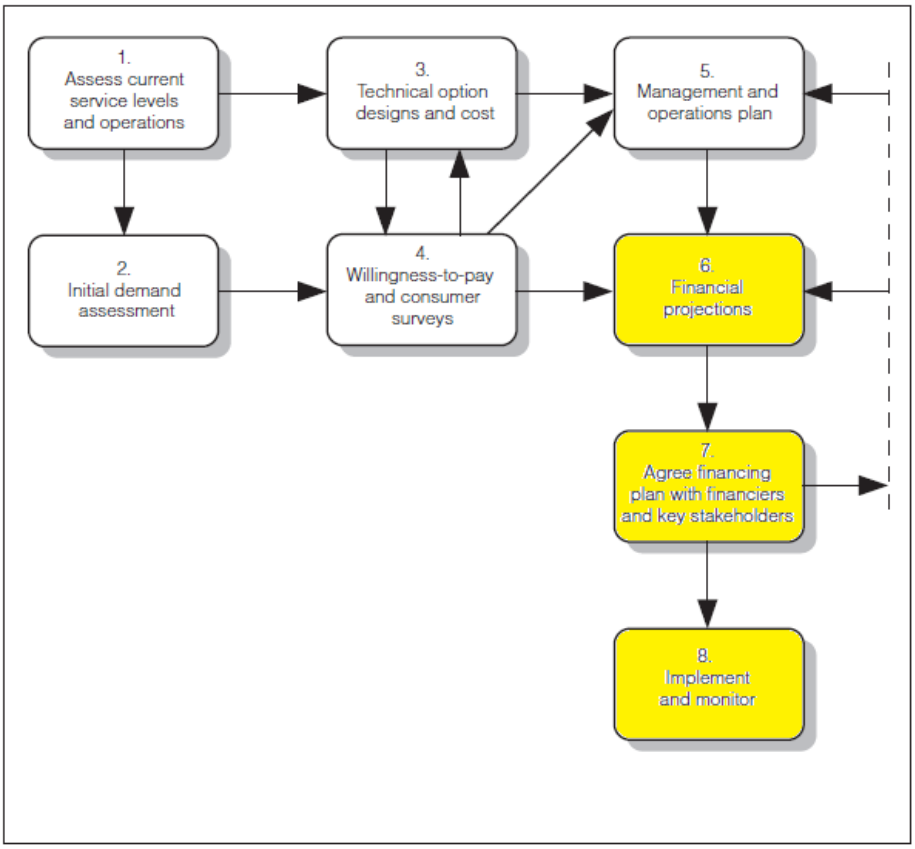

Figure 20: Analytical framework for a planning process containing CVS, designed by Wedgwood & Sansom (2003)

Future research needs to establish the evaluation of implementing a credit component in financial schemes providing rural electrification in Nepal. This project provides an adequate case-study for further research and can serve as a basis to start evaluations and coming research.

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Appendices

Appendix A: Questionnaire for Contingent Valuation Survey

Household Improved Water Mill electrification WTP/ATP survey 2014

Introduction: my name is ..... (name of interviewer) and she is Fanny Verkuijlen. She is doing an internship for the SNV Netherlands Development Organisation, Nepal and the VU University in Amsterdam. We are carrying out a study on the Improved Water Mill programme, electrification potential and household decision-making on energy. Your participation in answering these questions is very much appreciated. Your participation is completely voluntary and your responses will be treated as **completely confidential.** We would like to ask the questions to the person who is most involved in electricity or fuel. This will take about 30 minutes in total.
If you indicate your voluntary consent by participating in this interview, may we begin?

Fill in by observation of interviewer:
District:..... **Location:**.....
Village:.....

Name of respondent:.....
Caste / ethnic background of respondent:.....
Gender of respondent:.....
Interviewer:.....
Date of interview:.....

Remarks/ comments:

Part A: RESPONDENT AND HOUSEHOLD INFORMATION

1. What is your age? …… years old

2. What is your relationship to the head of the household?

□ (0) Head	□ (4) Brother/Sister	□ (8) Parent-in-law
□ (1) Partner	□ (5) Niece/Nephew	□ (9) Grandparent
□ (2) Child	□ (6) Brother/Sister-in-law	□ (10) Other, specify.....
□ (3) Grandchild	□ (7) Parent	

3. What is the highest level of education you have completed?

□ (0) Did not go to school	□ (3) College
□ (1) Primary school	□ (4) University

□ (2) Secondary school □ (5) Other, specify.....

Only fill in if the respondent is NOT the head of the household → *otherwise go to question 5*

4. What is the highest level of education of the head of the household?

□ (0) Did not go to school □ (3) College
□ (1) Primary school □ (4) University
□ (2) Secondary school □ (5) Other, specify.....

5. Including yourself, how many persons in your household are:

Boys	Girls
..... (0) under 12 years	..... (3) under 12 years
..... (1) 12 – 30 years	..... (4) 12 – 30 years
..... (2) over 30years	..... (5) over 30years

Part B: SPATIAL INFORMATION & ENERGY SOURCES HOUSEHOLD

6. What is the distance of the house to the water mill?

□ (0) At the site of the water mill □ (2) 15 – 30 minutes walking □ (4) More than 60 minutes walking
□ (1) 0 – 15 minutes walking □ (3) 30 – 60 minutes walking □ (5) Other, specify …….

7. What is the distance of the house to the road?

□ (0) 0 – 15 minutes walking □ (2) 30 – 60 minutes walking □ (4) Other, specify …….
□ (1) 15 – 30 minutes walking □ (3) More than 60 minutes walking

8. Which major energy sources is your household dependent on?

Traditional energy	□ (0) Kerosene / petrol □ (1) Battery □ (2) Candles	□ (3) Fuel wood □ (4) Other, specify …….
Alternative energy	□ (5) Improved water mill □ (6) Solar lantern □ (7) Solar home system	□ (8) Solar PV □ (11) Biogas □ (9) Micro Hydropower □ (12) Other, specify ……. □ (10) Improved cook stove

9-14. What is the major source of energy for the following categories? (energy sources are the same as question 8.)

	Category	**Energy source**
9.	Lighting	
10.	Cooking	
12.	Radio	
13.	TV	
14.	Mobile charging	

Only fill in if the household makes use of electricity via the IWM-programme → *otherwise go to question 22*

15. Does the household make use of electricity every day?

□ (1) Yes □ (2) No

16. How many days per month is there no electricity?

□ (0) 0 days □ (2) 2 – 4 days □ (4) 6 – 8 days
□ (1) 1 – 2 days □ (3) 4 – 6 days □ (5) More than 8 days

17. How much cash has your household contributed to the IWM-installation?

…… NPR

18. How many days of labour has your household contributed to the IWM-installation?

…… days

Only fill in if the household is the owner of the mill. → *otherwise go to question 22*

19. Are you experiencing any problems with money collection from the households?

□ (1) Yes □ (2) No

20. How many days per month are spent on maintaining the water mill?

□ (0) 0 – 2 days □ (2) 4 – 8 days □ (4) 12 – 16 days
□ (1) 2 – 4 days □ (3) 8 – 12 days □ (5) More than 16 days

21. How much money per month does it cost to maintain the water mill?

..... NPR

Part C: INCOME AND EXPENDITURES

22. What is the main economic activity of the household?

□ (0) Subsistence farming □ (2) Self-employment □ (4)Part-time labour
□ (1) Commercial farming □ (3) Salaried-employment □ (5)Other, specify …….

Only fill in if the main economic activity of the household is farming → *otherwise go to question 25*

23. Who is the owner of the land?

□ (0) Individually owned □ (2) Community owned □ (4) Other, specify .....
□ (1) Family owned □ (3) Rented

24. How much is the total monthly income from farming (agriculture and livestock)?

□ (0) 0 – 500 NPR □ (3) 2000 – 4000 NPR □ (6) 8000 – 10,000 NPR
□ (1) 500 – 1000 NPR □ (4) 4000 – 6000 NPR □ (7) 10,000 – 12,000 NPR

□ (2) 1000 – 2000 NPR □ (5) 6000 – 8000 NPR □ (8) More than 12,000 NPR

25. Does the household receive income through remittances (money from family/friends living outside of the household)?

□ (1) Yes □ (2) No

27. How much is the total monthly income of the household (in cash)?

□ (0) 0 – 500 NPR □ (3) 2000 – 4000 NPR □ (6) 8000 – 10,000 NPR
□ (1) 500 – 1000 NPR □ (4) 4000 – 6000 NPR □ (7) 10,000 – 12,000 NPR
□ (2) 1000 – 2000 NPR □ (5) 6000 – 8000 NPR □ (8) More than 12,000 NPR

28. How many members of the household have an income?

□ (0) 0 members □ (3) 3 members □ (6) 6 members
□ (1) 1 member □ (4) 4 members □ (7) More than 6 members
□ (2) 2 members □ (5) 5 members

29. Does the household receive income in kind?

□ (1) Yes □ (2) No

30. Did the household spent money on the following items in the last month?

Yes = 1
No = 2

Food	
Water	
Clothing	
Household supplies	
Work supplies	
School supplies	
Electricity	
Kerosene / petrol	
Fuel wood	

Candles
Flashlight / batteries
Lights
Radio
Mobile phone (e.g. prepaid recharging
TV
Computer
Institutional payments (e.g. house, pro
Other, specify...

31. Make a ranking of your expenditures, from highest amount of money to lowest amount:

	Expenditure	**Ranking**
1 = top rank Most money is spent on the top rank	Food / Water / Clothing	
	Household supplies / Work supplies / School supplies	
	Electricity	
	Kerosene / Petrol / Fuel wood / Batteries	
7 = bottom rank Least money is spent on the bottom rank	Lights / Radio / Mobile phone / TV / Computer	
	Institutional payments (e.g. house, property)	
	Other, specify...	

32. How much money is spent monthly on these expenditures?

	Expenditure	**NPR**
Indicate in NPR how much money is spent per month.	Food / Water / Clothing	
	Household supplies / Work supplies / School supplies	
	Electricity	
	Kerosene / Petrol / Fuel wood / Candles / Batteries	
	Lights / Radio / Mobile phone / TV / Computer	
	Institutional payments (e.g. house, property)	
	Other, specify...	

33. How many times per year does the household spend money on <u>kerosene / petrol?</u>

□ (0) None □ (2) Every week □ (4) 2 – 5 times a month
□ (6) Once a year
□ (1) Every day □ (3) Once a month □ (5) Once in 6 months
□ (7) Other, specify …….

34. How many times per year does the household spend money on <u>fuel wood?</u>

□ (0) None □ (2) Every week □ (4) 2 – 5 times a month
□ (6) Once a year
□ (1) Every day □ (3) Once a month □ (5) Once in 6 months
□ (7) Other, specify …….

36. Have you taken on a loan in the last 5 years?

□ (1) Yes □ (2) No

Only fill in if the household has taken on a loan in the last 5 years. → *otherwise go to question 39*

37. How much loan did you take on? ..... NPR

38. What was the purpose of the loan? ……

38 A. To which organisation did you go for the loan? .....

38 B. What was the interest rate? ..... %

38 C. How much money is left to repay the loan? ..... NPR

38 D. How many years are left to repay the loan? ..... years

Part D: ATTITUDE TOWARDS ELECTRICITY

Only fill in if the household makes use of electricity → *otherwise go to question 48*

39-47. Please indicate for the following statements to what extend you agree or disagree with the statement. On a scale of 1 (strongly disagree) to 5 (strongly agree).

		Strongly disagree	Disagree	Neither	A
		(1)	(2)	(3)	
39.	I am happy I can make use of electricity.				
40.	My life has improved since I have electricity.				
41.	Since I started using electricity the amount of electric applications in my house has increased.				
42.	The IWM-electricity meets our daily light energy requirements.				
43.	Electricity is more reliable and durable than other options (eg. kerosene / fire wood).				
44.	Electricity is an affordable and useful technology for my house.				
45.	Electricity has a high safety level and is almost maintenance free.				
46.	If credit was needed for the IWM-electrification, I would have taken on a loan.				
47.	If credit is available to support me to start a micro-enterprise, I would go for this.				

Only fill in if the household does NOT make use of electricity → *otherwise go to question 56*

48-55. Please indicate for the following statements to what extend you agree or disagree with the statement. On a scale of 1 (strongly disagree) to 5 (strongly agree).

		Strongly disagree	Disagree	Neither	A
		(1)	(2)	(3)	
48.	I would like to make use of electricity.				
49.	I think my life will improve when I can make use of electricity.				
50.	If I would have electricity I would invest in electrical applications for my household.				
51.	Electricity is more reliable and durable than other options (eg. kerosene / firewood).				

52.	Electricity is an affordable and useful technology for my house.				
53.	Electricity has a high safety level and is almost maintenance free.				
54.	If credit is needed for the IWM-electrification, I will take on a loan.				
55.	If credit is available to support me to start a micro-enterprise, I would go for this.				

Part E: WILLINGNESS TO PAY FOR ELECTRICITY

56. How much are you willing to pay per month for electricity to light your house and charge your phone?

(0) 120 or less NPR		(7) 260 NPR	
(1) 140 NPR		(8) 280 NPR	
(2) 160 NPR		(9) 300 NPR	
(3) 180 NPR		(10) 320 NPR	
(4) 200 NPR		(11) 340 NPR	
(5) 220 NPR		(12) 360 NPR	
(6) 240 NPR		(13) 380 or more NPR	

57. How much are you willing to pay per month for electricity to light your house, charge your phone and power your TV or radio?

(0) 120 or less NPR		(7) 260 NPR	
(1) 140 NPR		(8) 280 NPR	
(2) 160 NPR		(9) 300 NPR	
(3) 180 NPR		(10) 320 NPR	
(4) 200 NPR		(11) 340 NPR	
(5) 220 NPR		(12) 360 NPR	
(6) 240 NPR		(13) 380 or more NPR	

58. Would you be willing to take on a loan to make the IWM-E installation possible?

□ (1) Yes □ (2) No

59. What is the total monthly tariff you would pay if you also had to repay the loan?

(x) I won't pay for a loan		(7) 260 NPR	
(0) 120 or less NPR		(8) 280 NPR	
(1) 140 NPR		(9) 300 NPR	
(2) 160 NPR		(10) 320 NPR	
(3) 180 NPR		(11) 340 NPR	
(4) 200 NPR		(12) 360 NPR	
(5) 220 NPR		(13) 380 or more NPR	
(6) 240 NPR			

60. For how many years would you pay extra tariff to repay the loan for the installation of the electrification unit?

- □ (0) I won't pay for a loan
- □ (1) 1 year
- □ (2) 2 years
- □ (3) 3 years
- □ (4) 4 years
- □ (5) 5 years
- □ (6) More than 5 years
- □ (7) Other, specify …….

61. How much would you, besides paying a monthly tariff, invest for electricity?

(0) 1000 or less NPR		(7) 8000 NPR	
(1) 2000 NPR		(8) 9000 NPR	
(2) 3000 NPR		(9) 10,000 NPR	
(3) 4000 NPR		(10) 11,000 NPR	
(4) 5000 NPR		(11) 12,000 NPR	
(5) 6000 NPR		(12) 13,000 NPR	
(6) 7000 NPR		(13) 14,000 or more NPR	

END: THANK YOU FOR YOU PARTICIPATION

Appendix B: Design of semi-structured interviews

A. Micro-enterprises on up scaling of productive-end use.

1. For what mechanical end-uses is the IWM used? Can be more than 1 option.
   Rice hulling, rice milling, chiura milling, oil expelling, saw milling, lokta beating, electrification, carpentry, milk cooling, aqua holding, others…?

2. For what electrical end-uses is the IWM used? Can be more than 1 option.

3. Since when are these end-uses practiced? Ask for how many years. And are they still practiced at the moment? If not, why are they not practiced currently?

4. How much did you invest in these end-uses?

5. How much capacity in kW is needed for these end-uses?

6. Are you satisfied with the capacity of the IWM-E?

7. Is there a market potential for your end-uses?

8. What is the income you receive from these end-use? In NPR per month.

9. What would be other possible end-uses of the IWM-E?

10. How come they are not practiced, what are the reasons for that?
    Capacity, market demand, lack of skills / knowledge / tools, costs too much money to invest?

11. Would you like to invest in new end-uses? How much money do you have to invest in new end-uses?

12. How much money could you earn with new end-uses?

13. If you practiced more end-uses, would you pay a higher monthly tariff for electricity?

14. For which end-uses do you think there is a market potential?

15. What are possible ways for marketing the end-uses? Where could you sell your products?
    Selling products to the villagers, selling to other villages, selling to other districts, others…?

16. Do you have knowledge on product marketing?

B. Community users group & community electrification committee (president and/or secretary) on key objectives of household questionnaire.

1. What are the main reasons for the community to choose IWM-E?
   Time saving, faster processing of agriculture activities, income increase, others…?

2. What are the main benefits for households from the IWM-E?

3. How much equity will the households invest in the installation of the IWM-E? Is this the same for all the households?

4. How much of the contributed equity will be paid in kind?

5. Do the mill owners receive any training on IWM management?
   For example on collection tariff or maintaining the mill?

6. Are there any problems with tariff payment from households to the mill owner?

7. Would the villagers be willing to take on a loan to invest in the installation of IWM-E?

8. Would other villagers judge a household negatively for taking on a loan? What is the perception of on taking on a loan?

9. How much would the households be able to pay as monthly tariff? For the electricity and the repayment of the loan together?

10. Are the villagers planning to start micro-enterprises once they have electricity from the IWM-E? Which end-uses are they planning to practice?

11. Do they think there is a market-potential for these end-uses?

12. Do they have the necessary knowledge and skills for these end-uses?